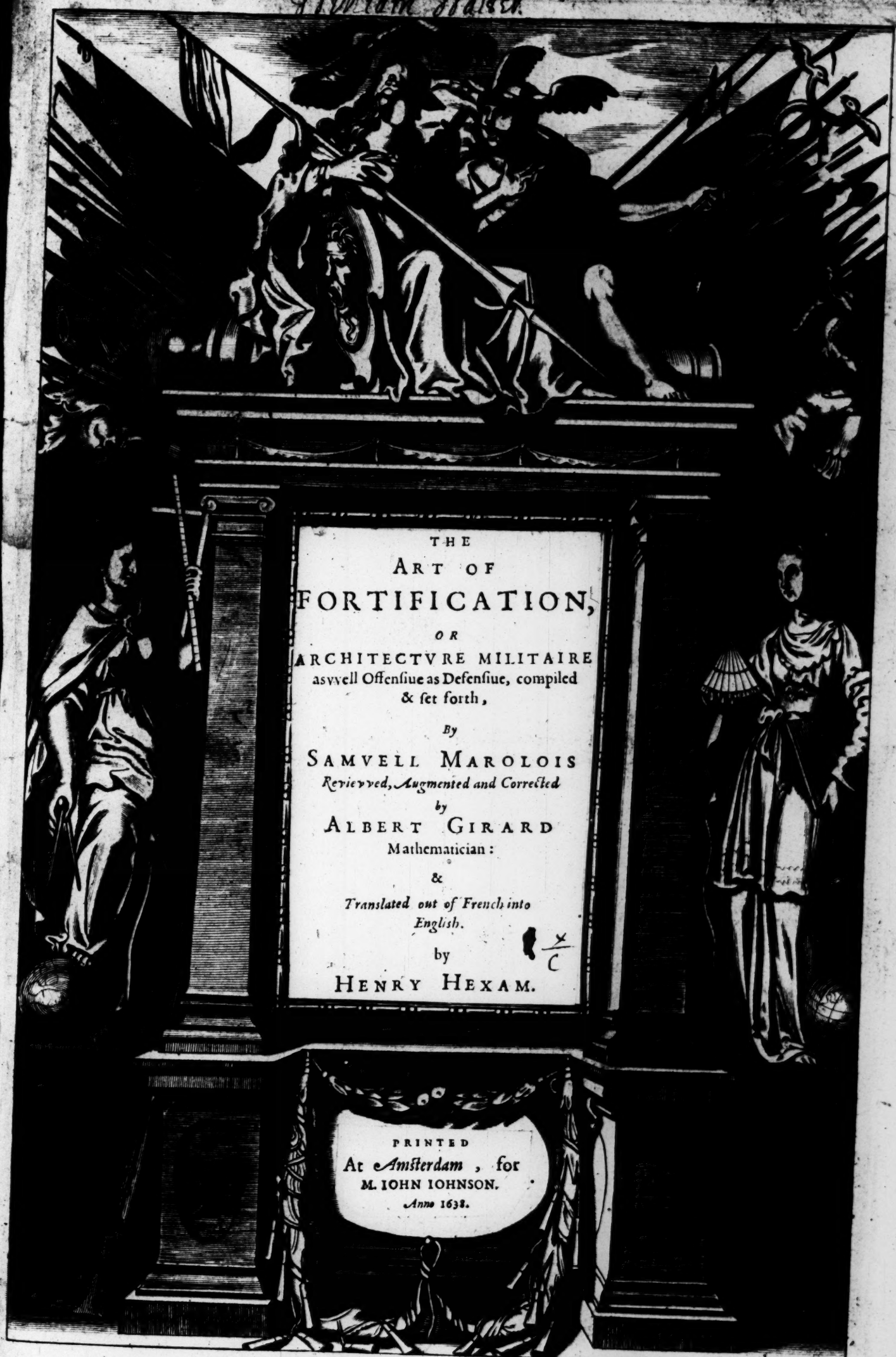
William Walter.



THE

ART OF FORTIFICATION,

OR

ARCHITECTVRE MILITAIRE asvvell Offensiue as Defensiue, compiled & set forth,

By

SAMVELL MAROLOIS

Revievved, Augmented and Corrected

by

ALBERT GIRARD

Mathematician:

&

Translated out of French into English.

by

HENRY HEXAM.

PRINTED

At *Amsterdam*, for

M. IOHN IOHNSON.

Anno 1638.

STC 17451

TO

The right honorable, & truely noble,

Sr. HENRY VANE KNIGHT,

MASTER CONTROVLER OF THE KINGS HOVSEHOLD,
& one of his Majesties most honorable privie Councellours of State.

WHen your honor was last here in the *Netherlands* Lord *Ambassadour* extraordinarie for his Ma^tie of *great Brittanie*; with the Lords the *States Generall* of the United Provinces: It pleased your honor, to employ your servant in collecting, and abbreviating some militarie *Abstracts*. Since which time, in regard of my longe service, I haue gained more experience, and studied my profession somewhat better. To this end, for the good of my Countrie, and Nation (for every man by a naturall inclination, ought to add some thing therevnto) I haue of late vndertaken, and written a treatise intituled, *The Principles of the Art Militaire, practised in the vvarres of the Vnited Netherlands, represented by figure, the vvord of Commaund, an demonstration*, disgesting the same into three parts, whereof the *first*, showes the dutie, and office of a *Captaine*, his inferiour officers, the true forme observed amongst vs in the *exercising* of a Companie, the *Ordering* of a Regiment, and our lawes, and articles of *Marshall discipline*. The *second* part treats of the severall duties of the officers of the field, and the diverse formes of ranging horse and foote in battle-ray, showne by Prince *Maurice* of famous memorie, & his brother his highnesse the Prince of *Orange* our Generall that now is, at sundry times, and in diverse places. The *third* part, handles the place & office of the *Master* (or *Generall*) of the Ordinance and all the officers vnder his traine and Commaund, together with the *Ordinance*, *Munition*, *Engines*, *Instruments*, *Materials*, and all necessarie *preparations*, and *Equipage*, belonging to an *Armie* & other officers depending on the warre. But yet (me thinkes) these three parts, are *defectiue* and *incompleate*, vnlesse a fourth be added therevnto, which is the excellent art of *Fortification*. To this effect, I haue translated into English out of French, the workes of two famous *Mathematicians* of our moderne times, namely Mr. *Samuell Marolois*, and Mr. *Albert Girard*, who haue written at large vpon this subject. As for exemple, what valour, and this art haue done, witnesse the famous siege of *Ostend*, for by the meanes hereof never was *towne* so brauely disputed, never *Fortresse* (in the memorie of man) so couragiously defended, having to doe with so braue an Ennemy, who was fainte during the time of three yeeres, three months, and odd daies Siege, to gett this towne (as it were) by *ynchmeale*: what should I say by ynchmeale? when they were driven to such *nonpluses*, that they could not gett a strawes breadth of vs, but held vp many daies, and weekes (finding such a resistance) their approches, before they could advance them any further: yea which is more, when they had approched, sapt, and mined into the very bowels of some *Bulvvarkes*, blowing them vp with the violence of pouder, steeple-high into the aire, each Ennemy then strived at push of the pike, who should become master of that falne Earth, to turne it vp one against an other. And at last being master of the deformed *karkeis* of a torne Bulwarke or two, found presently a new *retrenchment*, or cutting of cast vp before them; being then forced to sapp forward againe, and make new workes, and mines, which lasted so longe, and was so well disputed, till they gott the halfe of the towne, before they had the whole. This men, valour,

& *fortification* (by the help of *Almighty God*) can doe. Againe, this was one of Prince *Maurice* (of blessed memorie) his *master peeces*, for by this *art*, he was so warie, and carefull of the Liues of his men, that he choose rather, to spend the States a hundred pound, in casting vp a *trench*, a *Sap*, and a *vvorke*, rather then to hasard & loose the life of a man, so good a *Menagier* was he for the preserving of his men. This *Art* then, being of such singular vse, for the makeing of all manner of *Fortresses*, and *vvorkes* both *Regular*, and *irregular*, even from a *quadrangle* which is a fortresse with foure points or Bulwarkes, to a *Dodecon*, which is a towne or a fortresse with twelue *Bastions*, for the preservation of men in a Warre defensiue, comes in most humble wise, to craue your honours gracious patronage, that vnder your favour, and protection, it maye come to the view of the world, an maye be helpfull to such, as are desirous and *ingenious* to studie this noble art, which if it be acceptable vnto your honor, then I shall think my time well spent, and acknowledg my selfe much bound vnto your honor, and shalbe obliged not onely to pray vnto the Almightie, to preserue yow and yours in health; but also to crowne you hereafter with everlasting felicity, resting

Iour honors humble, and devoted
servant

HENRY HEXHAM.

THE FIRST PART OF REGVLAR FORTIFICATION, DEMONSTRATED BY THE DECEASED SAMVEL MAROLOIS.

And

Reviewed, corrected & augmented BY ALBERT GIRARD, SANMIELOIS.

GOd having found good to create Man, did with all prepare his affection for ſocietie, that by this meanes he might the longer preſerue him, and ſo make him become more ſtronge & able. According to which & to the ſame end, there were firſt built howſes, and lodgings, to keepe men from the injurie of the aire, as windes, ſtormes, raine, exceſſiue heate, and colde, as the ſituation of their dwellings, and the commodiouſneſſe of thoſe places did afford. And as by divine bleſſing, and their owne induſtrie, they attayned unto many Earthly riches, as famillies, cattell, and other goods: ſo by the inſtinct of nature, they ſought alwaies to ſtrengthen & defend themſelues with the beſt fortifications they could, that thereby they might not onely preſerue their bodies againſt the violence of their Adverſaires; but alſo their goods, kindred, and Aſſociates. To this end (as we may obſerue as well in ancient hiſtories, as alſo at this day in ſome Eaſt and Weſt Indian Nations) they droue in piles of timber, and made Empalements cloſſe one to an other, that encloſſing themſelues ſo narrowly together, they might be the better able to defend and reſiſt the furie of their Ennemies. But in

proceſſe of time, the defects of ſuch encloſſure being well marked, they began afterwards to make their Fortifications of a more ſolid, firme, and durable matter, as ſtone, brick, earth and ſuch like. And though experience taught them, that theſe their Empalements of wood, were not able to reſiſt fyre, & diuerſe other accidents, which might befall them: yet it is certaine, they uſed theſe and the like fortifications, till they found the harme & conveniencie, which they receiued by them. But neceſſitie, the Inventrix of Arts, found that walls built with ſtones and bricks were better. Theſe were in uſe and traine, till ſuch time alſo, as their imperfections were knowne, and that by the force of man, and Engines they were diuerſe wayes attempted; yea many times beaten downe & overthrowne: which made them ſeeke from time to time to remedie their defects: for perceiving that their walls were heretofore ſubject to be beaten downe (by Rames) and other ancient Engines; they made them (upon the right line of the wall) Spures, and roundles to hinder the beating of them downe, and to preſerue them the better from a breach, and tumbling downe, they gaue them the Talude, that is, a ſlooping towards the inſide of the place, that they might be the more able to reſiſt the violence & force of theſe Engines. Finally theſe walls were made after diverſe manners: firſt in a round forme, which, as on the one ſide, it was held the ſtrongeſt; becauſe theſe Engines beating againſt the wall cruſhed the ſtones, & made them ſtick the cloſſer together, in regard the circle exteriour was greater then the interiour, and that the Engines could not unfaſten, looſe and breake them but with great difficultie. So on the other ſide, it was impoſſible to defend ſuch walls, when approches was made unto them; becauſe no part of them could be diſcouered, or flancked: ſo that afterward they built thē in a ſquare forme, with ſmall ſquares in their angles, for the defenſe of their Curtaines. Then made them alſo Demycircles with angles interiour, and exteriour, and laſtly triangular wiſe, on the one ſide to reſiſt the force of the furious Canon, uſed at this day; and on the other ſide, that they might be the more capable to defend themſelues by diſcouering euery part of the wall, euen to the very foundation. And as invention of attempting is growne to the higheſt degree in theſe dayes, by reaſon of the longe experience of the warrs in theſe parts (which is the Schole of all military actions) and the abilitie, and capacitie of the Aſſaillants & Defendants: So am I of the opinion, that the Fortifications made in theſe Low Countryes, are the ſtrongeſt, exacteſt, & perfecteſt, which can be invented, and which haue bene made and practized, not by a ſimple Generall, but by one of the greateſt Captaines of the World, endowed with a ſingular courage and ſpirit, an excellent Mathematician, and is not onely a Prince of a great howſe; but alſo experienced & beaten in all militaire actions, and ſtratagems; aſwell offenſiue, as defenſiue: of which Fortification, we haue undertaken to treate briefly at this preſent, and as ſuccinctly as poſſibly may be.

Of the definitions.

I.

Foraſmuch then as the definitions of Fortification are by the dayly uſe of armes growne ſo common: it were in vaine for me (in my opinion) to make any further explication thereof: yet to ſatisfie the ignorant, we will marke out the angles, and ſides of a Fortreſſe, by the Letters of the Alphabeth, and oppoſite to the ſaid letters, ye ſhall finde their names, and appellations, as we may note by the figures 1. and 2, following.

Icno-

Icnographie, or ground-markeing.

1. *Figure.*

N. O. The ſide of the Polygone, that is many angles.
N. D. The line of the gorge,
D. C. The line of the flanke,
B. N. The Capitall line.
B. C. Q. R. The Moate.
P. The Raveline, or halfe mone.
Q. S. The covert way.
T. S. The Parapett thereof.
B. I. The line of defence.
D. K. The Curtaine.
K. F. The Parapett.
K. M. The Rampart.
A. N. The ſemy-diameter.
V. C. The flanke lengthned.
C. N. D. The angle forming the flank.
B. C. D. The angle of the ſhoulder.

Orthographie, or the Profile.

2. *Figure.*

A. B. The foote or baſis of the Rampart.
G. H. The heigth of the Rampart.
H. B. The talud (or ſlooping) of the infiel of the Rampart.
A. Y. The Talud on the outſide of the Rampart, or ſcharfe.
Z. D. The foote of the Parapett.
Z. E. The Parapett itſelfe.
D. F. The foote-banke.
F. G. The Terra plaine or bredth of the Rampart.
K. A. The way for the round, or the falſe bray.
I. K. The foote banke thereof.
I. M. The Parapett of the falſebray.
M. N. The Scharfe.
P. O. N. M. The moate.
P. O. The Counterſcharfe.
P. Q. The Covert way.
R. Q. The foote banke thereof.
T. S. R. The Parapett of the Covert way.

The other names, which haue neede of explanation ſhalbe declared in their due places.

Before we come to inſtruct yow particularly in the Art of Fortification; we will briefely treate of the calculation thereof: In which ſupputation, ye ſhall haue firſt ſett downe the knowne termes, and under them the diſpoſition of the Characters or Letters: beginning with a ſquare fortreſſe with foure angles, or Bulwarks, and proceede on to a *Dodecagone*, a fortreſſe with twelue angles, or Bulwarks, makeing upon every *Polygone*, 3 or 4 Trialls, that afterwards one may chooſe the beſt of them: and becauſe the angles will not be much altered by the diverſitie of the trials: I haue thought good to giue this generall rule for them following.

It is a thing generally received of all men, that a ſquare fortreſſe with foure Bulwarks, is not ſo good as a *Pentagonall* with fiue angles, nor a *Pentagonall* ſo ſtronge as an Exagonall with ſixe, and ſo conſequently of the reſt. If the cauſe thereof be ſought out; one may obſerue that this proceedes from the ſmallneſſe of their angles; as not being able to beare ſuch a body of a Baſtion, as the ſubſequent *Polygones*: ſo that a ſquare fortreſſe for this reaſon, wilbe more defective, then the *Pentagonall*,

and this leſſe defenſive then the Hexagonall, and ſo well the reſt following even to a *Dodecagone*, which hath the angle of the Baſtion right, which is the cauſe, that conſtraines one to make the angles flanked leſſer, then the reaſon of building well doth require, that is, the flanks too litle, the Gorge too narrow, and the line of defence too longe. To encreaſe then proportionally the angles of Fortreſſes, according as the angle of their *Polygone* augmenteth; we will take then the halfe of their angles, and adding thereunto 15 degrees, the ſumme wilbe the angle of the Bulwarke, which we terme the angle-flanked, and if the angle-flanked be ſubſtracted from the angle of the *Polygone*, there will remayne the double of the angle flanking interiour, which double being ſubſtracted from 180 degrees, then will remayne the angle flanking exteriour, called the *Tenaille*, and if ye add to the angle flanking interiour 90 degrees, then the ſumme wil be the angle of the Shoulder.

To finde out the angle of the *Polygone* from the number of its ſubſtract, namely 2, the remaynder muſt be multiplyed by 2. and the product wil be the number of the right angles, which ſuch a *Polygone* containeth, as ye maye ſee by this exemple following.

5 angles of a Pentagone.
2
remaines 3
2
product 6
90 degrees
108 the angle of a Pantagone.

Or thus.

180
72 degrees
180 degrees the angle of a Pentagone.

And by the ſame rule ye ſhall finde the angles of the Subſequent *Polygones*, beginning from a ſquare Fortreſſe to a *Dodecagone*.

4	5	6	7	8	9	10	11	12	
90	72	60	51 3/7	45	40	36	32 8/11	30	the angl. of the center.
90	108	120	128 4/7	135	140	144	147 3/11	150	the angle of the Polig.
45	54	60	64 2/7	67 1/2	70	72	73 7/11	75	The halfe.
15	15	15	15	15	15	15	15	15	
60	69	75	79 2/7	82 1/2	85	87	88 7/11	90	The angle flanked.
30	39	45	49 2/7	52 1/2	55	57	58 8/11	60	the double of the ang.
180	180	180	180	180	180	180	180	180	The flanke interiour.
150	141	135	130 5/7	127 1/2	125	123	121 4/11	120	The flank exteriour.
15	19 1/2	22 1/2	24 9/14	26 1/4	27 1/2	28 1/2	29 7/22	30	The flank interiour.
90	90	90	90	90	90	90	90	90	
105	109 1/2	112 1/2	114 9/14	116 1/4	117 1/2	118 1/2	119 1/22	120	the ang. of the should.

Remaines

And seing the angle flanked of a *Dodecagone* is right, and able to resist a batterie, which is also made alwayes with right angles to shake the more the face of the Bulwarke; one must fortifie the *Polygones*, which are aboue the *Dodecagone*, with a right angle, that the line of defence may come the more into the curtaine, that one may giue the more fire upon it: but the *Polygones*, which are under a *Dodecagone*, must be fortified, according to the precedent Table, and the calculation thereof shalbe made hereafter.

Some times we augment, aswell the angles of the Bulwarkes, as the *Octogone*, a Fortresse with 8 angles or Bulwarks, with a right angle, and those aboue are alwayes right, & those under diminishing to the square fortresse (which hath the angle of its Bulwarke onely of 60 degrees.) According to which the Bulwarks are somewhat larger, and the gorges and flanke greater then the former, but the second flanks lesser. Now for the finding out of every angle, ye must doe this following, where ye may observe, that in the manner aboue sayd, the angles flanking interiour are the fourth part of the angle flanked, or the 1/4 of the angle of the *Polygone*.

IIII.	V	VI	VII	VIII		
90	108	120	128 4/7	135		of the Polygone.
60	72	80	85 5/7	90		Flanked.
90	72	60	51 3/7	45		of the center added thereunto.
150	144	140	137 1/7	135	the angle	Flanking exteriour.
30	36	40	42 6/7	45	the angle	double of the angl. flank. interiour.
15	18	20	21 3/7	22 1/2		Flanking interiour,
90	90	90	90	90		which is the flanke alwayes
105	108	110	111 3/7	112 1/2		of the shoulder.

In the same manner also may be made right the angle flanked of the *Decagone*, a Fortresse of ten Bulwarks, where ye must note also, that before wee proceede further

further, we will make use in the supputation following of the tenths or decinall numbers; which though it gives some imperfection: yet seing the things, which we omit therein are of no great consequence, it were ridiculous to make any further search thereof; considering likewise that the tables of *Sines*, *tangents*, and *secants*, are one and the same; I thought it good therfore to make use of these following.

THE I. QUESTION.

The 1. *Figure*, *&* 1. *Plate.*

Let there be made upon a Square a fortification of foure Bulwarkes, so that the line of the Gorge be 7 parts: DI the curtaine 21, and IF, which is the flanke of 5, and from the angle of the flanke is drawne the line of defence by the angle of the Shoulder, to giue it a face. The question is how many the angles will be, and every line of the same fortresse, when as the line of defence will take up 600 feete. Now the length of a foote is sett downe in the 25 modell of Geometrie, noted by 1, and is divided into 12 ynches, & the ynch into 10 equall parts, and is the same foote, whereof 12 makes a rodd, which his Excell. uleth in all his Fortifications.

ALBERT GIRARD.

THe Authour hath here aboue so disposed his calculations, that in stead of explaining them briefly, he confounds them teadiously, as if heretofore there had bene noe certaine rule sett dovvne in vvriting, to calculate lines and angles as is ordinarily done by the Trigometrie *of plaine Triangles, although there haue bene a number of Authours, vvhich haue treated of them, th'one after one manner, th'other after an other; and the most part of them commixed vvith longe discourses, vvhich moved me not longe since, to putt into light some tables of* Sines *in a portable volume, vvith the most succinct method that possibly could, touching the supputation of such plaine triangles, reducing them into foure diverse cases, vvhere I did insert in their places, some of my ovvne inventions to the purpose, knovvne as I suppose to none others heretofore; so that it cannot be, but having 3 knovvne termes, in a triangle, but that one maye knovve the other three, or one of them onely, vvhich one desires, as the Reader may knovve it; the manner & order thereof being much more facile, & easier to conceiue, then the reading of our Authour in his former editions, being obscure, troublesome, and hard to be attayned unto. For this reason the Learners of this science, are required to be forevvarned before they come to the reading of this booke; & are advertized hereby, that vvhen it is sayd, a triangle hath three termes, he must understand knovvne, or given, and that vvhen I say that a triangle right-angle hath three termes, that then I am bound but to shevv tvvo of them; seing that this vvord (right-angle) presupposeth that the triangle hath a right angle, to vveet of* 90 *degrees: moreover, that touching this present question, these* 7, 21, 5 *parts, demonstrate the reason of the lines* ND, DI, IF, *and not the quantitie of the same in feete, as is necessary to finde in the manner follovving.*

To finde

To finde out the Angles.

IN the triangle right-angle CDI, the ſide CD, is to DI, as 5 to 21, (for CD being of 5 parts, then DI wilbe the 21 thereof) therefore the angle DIC, wilbe found for 13: 24 its double CLD 26: 48, and its adjunct CLF flanking exteriour, wilbe of 153: 12. Now in the figure *quadrilatere*, or of foure-ſides, ABLH, the angle exteriour BLH is alwayes equall to the 3 interiours B, A & H; now A 90. the angle of the center, being taken from BLH, 153: 12, there will remaine the two Demy-flankes ABL, & LHA 63: 12. for one entire flank ZBC: & ſeing that the angle of the Shoulder BCD, is exteriour in the triangle CDI, it wilbe equall to the two interiours D. 90. and 1. 13; 24, and therefore the Shoulder C, wilbe 103. 24.

To finde out the Lengths.

IN a triangle *ambligone* BNI, the ſide BI is 600 feete, & the angles are found, therefore the other termes ſhall be found, to wit BN the Capitall line 196, 64, & NI, 444, 62, but ND is the third of DI (for ND being 7, DI is 21 by the *Hypotheſes*) therefore the fourth part of the found NI, wilbe ND, 111, 15 the Gorge, & the reſt wilbe 333, 46, for DI, the Curtaine, now DI to DC is as 21, to 5: therefore one may ſay, if 21 giues me 5, how many DI 333, 46, giue me? facit for CD 79, 40. & ſo CI wilbe 343, 84, which taken from BI 600, there will remaine BC 257, 16, for the face.

Finally, the triangle right-angle VDH hath three termes. DH 600, and the angle H equall to HDI. 13: 24 (becauſe of the parallels DI; VH) then yow ſhall know VD 139, 05, & VH 583, 67, from which ſide ſubſtract VP (equall to Demy DI) 166, 73, there will remaine PH 416, 94, whereof the double wilbe for BH 833, 88, and PA wilbe 416, 94, for it is equall to PH, and thus muſt ye doe with the reſt following.

The 3. Figure, 1. Plate.

Let there be a ſquare Fortreſſe, whereof the curtaine DI being 4 parts; the flanck CD ſhall haue 1 of them, and alſo the Gorge 1: The defence running from the angle of the flanke, formeth the face, & the length BI is of 600 feete, one requires the greatneſſe of the other lines of the ſame Fortreſſe.

To finde out the Angles.

THe triangle right-angle CDI hath three termes, as the reaſon of the ſides CD, 1, to DI, 4, therefore the flancking interiour CDI wilbe 14 degrees & 2 minutes, whereunto add D 90 degrees, then the Shoulder BCD wilbe 104: 2; now if ye double the angle CID, it wilbe 28: 4, CMD, and its adjunct CMF, 151: 56 for the angle flancking exteriour, from which ſubſtract the angle of the center A 90: there will remaine 61: 56 for the angle flancked entire B, and thus much for the angles.

For the

For the ſides.

THe triangle BNI, hath three termes, to witt, BI 600 feete, and the angles B, 30. 58. & N, 135. 1, 14. 2, ſo one ſhall finde the lines BN 205, 76 & NI 436, 59; but in regard that ND to DI is as 1, to 4, according to the Hypoteſe, then ND will be the fifth of NI, where will follow that ND wilbe 87, 32 (and DC as much) and DI the reſt 349, 27. Now ſeing that in the triangle right-angle CDI, the ſides CD, DI are notified, one ſhall finde the Hypotenuſe CI of 360, which taken from BI 600. there remaines the face BC 240. Finally, in the triangle right-angle VDH, which hath 3 termes DH 600, the angle H, equall to CID 14. 2, ye ſhall haue VD 145, 49: alſo VH 582. 09, from which take VP 174, 64. (equall to the demy-curtaine DI) there will remaine PH 407, 45, alſo PA its equall: then in the triangle right-angle APH, ye ſhall finde AH 576. 22 from whence take BN or HO, the capitall line 205, 76, there will remaine AO 370, 46, & in takeing VD, from AP, there will remaine the perpendicular of the Center, A upon the middeſt of the curtaine 261, 96. Now BH wilbe 114, 90. as being the double of PH.

4. *Figure.* & 1. *Plate.*

In this ſquare Fortreſſe, the defence BI is 600 feete, and the angle flanked 60 degrees, whereof DBC is the fourth part, which is 15 degrees, the queſtion is what the quantity of the parts of ſuch a Fortreſſe wilbe?

For the angles.

SEing that the line flanked is 60, then in the triangle BNI the angle B wilbe 30, & N 135, (the adjunct of A NI 45:) whereof the angle remayning BIN wilbe 15 degrees; therefore the triangle BDI wilbe *Iſoſceles*, that is, two ſides a like, ſuch that DBI is aſwell 15; as BID; The Shoulder C wilbe 105, and in the triangle DMI, the angles upon the baſis are each of them 15 degrees, the remaynder M will be then 150 for the flanking exteriour BMH.

For the ſides.

THe triangle *Iſoceles* BDI hath three termes, the defence BI 600 feete, and the pointed angles every of them 15 degrees. Therefore DI the Curtaine wilbe 310, 584. Alſo the triangle CDI, hath three termes, the angle D right; I 15. and the curtaine DI, then CD the flanke 83, 217, & CI 321, 535, which being taken from BI 600, there will remaine BC the face 278, 465. Moreover in the triangle IBN, the angles B 30, I, 15, & the defence 600: ſo then BN the Capitall line wilbe 219, 623, & NI 424. 268. from whence DI being taken there will remaine the gorge ND, 113. 684. Moreover, the triangle BIL having three termes, L right, B equall to CID 15. and BI 600, then IL wilbe 155, 292, & BL 579, 558, and takeing from it PL 155. 292. (which is the halfe of the curtaine) there will remaine BP 424, 266 for AP; alſo its double being BH 848, 532, one may alſo eaſely knowe BA 600.

The 5. Figure. & 2. Plate.

ALBERT GIRARD.

Heitherto of the defence drawne from the angle of the flanke, but in those following, there is a second flank, and the distance of the angle of the flank, euen to the angle flanked, which is called Fichant.

The 5 figure is the dessigne or draught of a square Fortresse, whereof the line of defence fichant DH maketh 600 feete, the angle flanked 60 degrees, the line HB is divided into 7 equall parts; whereof the one which is betweene the Characters 1.2. is subdiuided into 5 equall parts, and from the center B, is made the Arch, 4 N cutting the capitall line at N, from which point is drawne NDZ parallel to BH, and from the point V (which is in the character 2) the perpendicular VD; the question is how many these lines, and the angles of such a Fortresse, will make?

For the lines in parts indetermined.

FOrasmuch as BH contayneth 35 such parts as BN 9; BV 10, VH 25, ye shall haue in the triangle right-angle BTN termes enough to knowe BT, or TN 6,364, and TV or, ND 3,636: Also the triangle right-angle DVH, hath three termes, VD equall to TN, 6364, & VH 25, then DH wilbe 25,797 parts or the same DH is 600 foote. We must then calculate according to this reason, the lines aboue mentioned to bring them into feete, saying, as followeth.

For the lines in parts determined, to vvit, brought into feete.

THe 25,797 parts, make 600 foote, how many then will BH 35. come to? There wilbe for BH 814, 04 foote, likewise VL, or DZ the curtaine may be made soe; BH 7 parts make 814, 04 foote, how many VL 3? it will come for the curtaine to 348, 87, & for BN the Capitall line ye shall say, if 35 giues 814,04: how many 9? ye shall haue for BN 209.32: and so of the other: for TN, or BT, or VD wilbe 148.02, & TV, or the Gorge ND 84 57. and seing that BH is knowne, also VL the halfe of the remainder wilbe BV 232, 58. In the triangle right-angle BVC, the angle B wilbe 15 degrees: (for PBO is 45, & CBO 30:) and BV being knowne, therefore BC the face wilbe 240,78, and VC 62,32, which being taken from VD, there will remaine CD the flanck 85.7; and therfore the triangle right-angle CDI, shall haue 3 termes, the angle C 75, & CD 85,7. soe DI wilbe 319, 84, CI 331, 15, likewise BI flancking 571, 93. & I,Z 29. 03 for the second flancke. Now OP is knowne as being the halfe of BH.

Now of the Pentagons, or Fortresses with fiue angles or Bulwarks.

6. Figure. & 2. Plate.

In the Pentagone, a Fortresse with fiue Bulwarks, KFBDL, let the

line, KL be 63 rods, & divided into 7 equall parts, whereof the Capitall line KA is 2 of them, alſo LE, and from the Character 2 (or G) let GB be the perpendicular. Alſo the angle flancked is 69 degrees, according to the precedent table, how many then wilbe the lines and the angles of ſuch a Fortreſſe?

ALB. GIRARD.

Before vvee come to the Conſtruction hereof, take notice, that KA *in this figure is not anſvverable to the length of* KG, *yet ye muſt ſuppoſe them to be equall, aſvvell as the cipher* 1, *and the letter* H, *are tvvo differing points, vvhich vvould haue bene the better diſcerned, if the figure had bin vvell made, vvhich may ſerue as a fore-vvarning for ſome figures follovving, upon vvhich one ought not to ſtand ſo much as upon the Suppoſitions, or* Hypoteſes *of the Propoſitions.*

The triangle right-angle KHA hath three termes, KA 18 rodd; the angle AKH 54 degrees, which being ſo KH wilbe 10, 5802, & HA or GB 14, 5623. Now if ye take away KH from KG, there will remaine for AB the Gorge, 7.4198. Item the curtaine BD wilbe 27 rodd, being equall to GM. And becauſe the angle flancked is 69 degrees, if ye add thereunto the angle of the Center, which is 72, ye ſhall haue the angle flancking exteriour, 141 degrees, the halfe of its adjunct for the interiour 19½ degrees. The triangle right-angle KGF, hauing 3 termes, KG 18, GKF 19½: the face KF wilbe 19, 0953, and FG 6.3741, which being taken from GB 14, 5623. there will remayne FB (the flanck) 0, 2828. then the triangle right-angle FBI may be knowne, ſeing that FB is found, and the angle F, 70½ the complement of 1; therefore BI wilbe 23.1227, which taken from BD 27, there will remayne ID for the ſecond flanck 3, 8773, alſo FI wilbe found to be 24, 5297, whereunto add KF 19. 0953, and ye ſhall haue KI, the defence flancking 43. 6250, finally the triangle right-angle LGB, hauing three termes, to wit LG 45 rodd, and GB 14, 5623; one may eaſely know BL, and the diſtance of the Center of the Fortreſſe by K, becauſe that KP is 31½ rodd, and the angle AKP 54 degrees.

The 7. Figure, & 2. Plate.

In a Fortreſſe Pentagonall, BOV, let AB the deffence flancking be 50 rodd, the Flanck ED 9 rodd, and the angle of the Bulwarke 72 degrees. How many then will the other parts of the ſame make, when the ſecond flanck AG makes fiue rodd.

THe angle of the *Polygone* is 108, the halfe is 54 for FBQ, to which add CBF 36 degrees by the Hypoteſes, you ſhall haue 90 for CBQ, but CF is paralell to BQ therefore BCA right, the triangle BCA wilbe then the right-angle, and BA of 50, and the angle B of 72 degrees, then ye ſhall finde BC, or QD to be of 15, 451, and CA 47, 553, and the angle A 18 degrees. Alſo in the triangle right-angle EDA, the angle A is giuen, and the ſide ED 9 rodd, by the *Hypoteſe*, then EA wilbe 29, 12463, & DA 27, 69912; now if ye take EA from DA, there will remaine BE the face 20, 87537, and if ye ſubſtract DA from AC, there will remaine CD, or BQ. 19.854. Alſo the triangle

triangle right-angle BCF, hath 3 termes, BC and the angles; in fine BF the capitall line wilbe 19, 097 & CF, 11, 226, which being taken from CD, there will remaine FD 8, 628, the Gorge; now if to DA, ye add AG 5 rodd, the second flanck, ye shall haue the curtaine DG 32. 69912, to which add twise BQ, and ye shall haue BV 72, 40711 its half BK 36, 20355, and so the triangle right-angle BKO, hauing 3 termes, the angle KBO wilbe 54 degrees, ye shall finde BO 61, 593099, and KO 49, 82984. Finally VB, BQ being knowne, then the triangle right angle DQV, hauing 3 termes giuen VQ, & QD; ye shall finde the fichant DV easely.

ALB. GIRARD.

IF one vvill consider the difference vvhich is betvveene this operation, and that of our Authour published in his former Editions, he shall finde that this question is defectiue, for I haue added thereunto (that the second flanke AG is 5 rodd) seing that in all such questions, vvhere there is a second flank, he ought to haue set dovvne 5 knovvne termes & neither more nor lesse, vvithout the one depending on the other, as in this present, the name of the Fortresse, to vvit, Pentagonall *is a terme, in the second place there is the defence; then the flanck, the angle flancked, and the second flancke, vvhich are fiue termes: vvhere ye must note, that vvhen there are reasons in the proposition, and that though a reason hath tvvo numbers, nevertheless it is but one terme; but vvhere there is no second flanck (as in the figures of the first plate, then 4 termes vvill suffice.) Finally, my Authour had so ordained his Supputation, that in stead of makeing an addition, or a substraction; he made the rules of three very great, so that ye must imagine it vvas easier for me to change all, then to recorrect it, hauing no other respect, but to the explication of the figures, and as much as is lavvfull and possible to shevv his intention, vvhich I am bound to doe. Moreouer, if peradventure some one should finde this manner of operation strange, vvhich I haue vsed heitherto, it is requisite for him to knovv also (be it spoken under correction) that he vnderstandeth not much, if he doth not practize it soe himselfe in other Subjects, yea though I had not sett dovvne one onely number; vvhich I should haue done already heretofore, if I had not had regard to the obscuritie, vvhich students might pretend to finde, vvhich hauing cleared heitherto, ye may goe on vvith the more assurance in the rest follovving: and must also knovv, that the 8 figure vvas left vvithout explication by the Authour.*

The 8. 9. 10 Figure. & 3. Plate.

In this figure Pentagonall, the angle ELO is divided into 2 equall parts by LD, the flanck FB 9 rodd, the angle flancked 69 degrees, and the curtaine 30 rodd, how many then will the other lines & angles be?

THe angle of the *Polygone* is parted in the midst by KA, and the angle AKF is knowne, also the rest shalbe FKG, or its equall F B, whence followes that the triangle right-angle FBI shall haue 3 termes FB, and the angles, therefore the other 3 termes wilbe knowne, also the whole line DB, and the part BI, ergo the rest ID is the second flanke. The triangle KBI hath three termes, the angle I found, BI & K (the fourth part of the flanck by consequence the 3 termes remayning are knowne, and the difference of the found lines KI, IF wilbe for the face KF; which makes that in the triangle right-angle KGF wilbe knowne KG. GF; and if to KG doubled, ye add the curtaine, ye shall haue KL; also KG to the curtaine is for GL, or XB If to GF ye add FB, ye shall haue LX, and therefore in the triangle right-angle LB wilbe

knowne; ſeing that LX, XB are found. Moreouer, in the triangle right-angle LXE, the angle E is a demy *Polygone*, and the line LX being knowne, ye ſhall haue LE the Capitall line, and XE taken from XD (equall to KG) there will remayne DE the Gorge.

BI	25, 4151	KL	75, 8459
FI	26, 9617	XB	52, 9233
ID	4, 5848	LX	17, 1175
KI	51, 2795	LB	55, 6227
KF	24, 3178	LE	21, 1583
KG	22, 9229	XE	12, 4366
GF	8, 1175	DE	10, 4863

The 9. Figure, vvhich is the 8. 9. 10. *& 3 Plate.*

In the former figure Pentagonall, there are other *Hypoteſes* BL, fichant 60 rodd, the angle DLM 36 degrees, and 45 minutes, DM 17 rodd, and the angle OLE parted in the midſt by LM.

THe angle MLE is 54: from which take DLM 36, 45; there will remaine 17, 15; for DLE its quadruple or fourefould for the angle flancked 69: ye muſt firſt calculate the triangles right-angles MDL, QEL, whereby is found DE the Gorge, LE the Capitall line, and ML in the triangle right-angle LGB; the line of defence LB 600, and GB 17; therefore ye ſhall finde GL, which added to KG equall to ML, ye ſhall haue KL; [illegible] rake ML, from it, there will remaine GM for the curtaine BD, in the triangle MLO, ye ſhall find the face OL, & MO, which taken from 17, there remaines OD for the flanck, & the triangle right-angle ODC may be knowne, becauſe the angle C, is equall to MLO 19½, then CO & CD being notified, ye ſhall find CL & BC, and from the Center of the Fortreſſe wilbe knowne the diſtances towards K, P, A.

DE	10, 41454	MO	8, 06179
LE	21, 01319	OD	8, 93821
ML	22, 76572	OC	26, 77657
GL	57, 54128	CD	25, 24075
KL	80, 30700	CL	50, 92758
BD	34, 77556	CB	9, 53481
OL	24, 15101	A(†)	47, 30000

The 10. Figure, vvhich is the 8. 9. 10.

In the figure Pentagonall, let LB fichant be 60 rodd, and LC the defence flancking 50, 92758 fifth-parts. Alſo BC the ſecond flancke 9, 53481, and the angle OLE parted in the midſt by LD.

THe triangle BCL hauing the three ſides giuen, then ye ſhall finde the angle C, or the lengthning of the baſis BC unto the perpendicular X, as followeth here, the baſis BC, 9, 53481 giueth me the Summe of both the other ſides, 110, 92758, how

how much then will their difference 9, 07242 giue? it will come to 105, 54816, from which take the basis (because that the perpendicular falls without, which is seene, when the sayd quotient is more then the basis) there will remaine one number, whereof the halfe is CX 48, 00668, this being done ye must calculate the triangle right-angle CLX, by which ye shall know the angle C, or LMO, which taken from LME, the remainder wilbe OLE, 34½, and the angle flancked wilbe the double of it 69: also ye shall haue LX, or MD, and then shall ye calculate the triangle MDL (for the angle MLD is knowne) seing it is equall to MLO 19½, and OLD 17½: Also the triangle LQE, whereby ye shall finde the Gorge, the Capitall line, & CD, then by the triangle ODC is found the flanke, & after that the face: & if to CX aboue sayd, ye put BC being giuen, there will come out BX, or GL, to which add ML by addition, then by substraction ye shall haue KL, and the curtaine BD, whereof the numbers agree with those of the precedent question.

The 11. *Figure.* 3. *Plate.*

In this figure *Hexagone*, that is, a Fortresse with sixe angles or Bulwarks, let the Curtaine be sesquialtere, or halfe as much againe to the face, & the face to the flancke doubled-sesquialtere, the angle flancked 75 degrees, and DP distant from the points 70 rodd. Wee must finde out the rest.

SEsquialtere, or one and a halfe, is as 3 in respect of 2; twise sesquialtere is as 5 to 2: so that BH, DC, CB wilbe as 15, 10, 4, whereunto if yee add 4 cifphers to each of them, DC wilbe 100000 sines of the right-angle. Now ADF is 60, and ADC 37½, then CDF wilbe 22½ degrees; therefore CF 38268, and DF 92388 also KP; but BH, or FK is 150000, then DB wilbe 334776 parts, which make 70 rodd by the *Hypotheses*, wee will bring then these lines into Rodds, according to this reason following; because 334776 parts make 70 Rodd.

	partes.	they will come to.		
How many	150000	31,	364	BH
	100000	20,	909	DC
	40000	8,	364	CB
	38268	8,	002	CE
	92388	19,	318	DF

And seing that PD, DF are knowne, FP wilbe also; and by FC, CB, wilbe knowne FB, or AE, 16. 366. now by the 47 pro. 1 of Euclide BP fichant wilbe 53, 259: And if one calculates the triangles CBG, DEA, ye shall finde DG, 42, 765; and DE, 9, 448, ergo EF, or AB the Gorge wilbe 9, 87; the distance from the Center to D, is equall to DP, 70 rodd.

The 12. *Figure.* & 4. *Plate.*

Let DP be 72 rod, the angles of the Bulwarks are 72 degrees, the curtaine BH 32 rod, the flancks of 8, 3638, fourth of rodds, how many then wilbe the other parts of this Fortresse Hexagonall?

Seing that DP is 72, & BH, or FK 32, then the halfe of the reſt wilbe 20 for DF, and alſo the angle ABF being 60 degrees, and ADC 37½, then CDF wilbe 22½ degrees: whereby ye ſhall know then the triangle right-angle CDF. Secondly, FC found, with CB giuen, will make knowne FB, but PF is 52, then the triangle right-angle BFP hath the ſides BF, FP knowne, & BP wilbe knowne in the triangles right-angles ADE, CBG, their termes will ſuffice to make the reſt to be underſtood. when ye haue DA, its halfe wilbe for DE, which taken from DF, there will remaine AB.

DG	21,	64780	DE	9,	61172
FB	16,	64800	AB	10,	38828
BP	54,	60000	GH	11,	80804
AD	19,	22344	DG	43,	50349

The 13. Figure.

In this Figure *Hexagonall*, the ſecond flanke is in the flanke as 6 to 7, the flanke hath its gorge as 7 to 10, the Gorge to the line of the *Polygone*, as 2 to 9. the queſtion is how many they, & the other dimenſions wilbe, when as DH makes 60 rodd.

IF ye make GH 6, then HO wilbe 7, & HI 10, the Curtaine wilbe 25; Then ye ſhall calculate the triangles CBG, DAG by which ye haue the angle G, or his equall CDF, & the face DC. and then in the triangle DCF, the lines DF, FC, FB, FP, and finally BF 44, 93555, which make 60 rodd. for which reaſon one muſt reduce the parts into rodds: but this reaſon may be ſett downe more eaſie, in takeing but 7, 48926, which make 1000000 parts; Now if ye had rather worke it by multiplication, without diviſion, then ye muſt take but 100000 parts, which make 13352 rodd, and ſo ye ſhall finde

DC	25,	38302	DP	81,	01484
CB	9,	34672	BH	33,	38115
BA	13,	35246	The angle flancked 79. 33.		

The 14. Figure, the 1. of the two.

In this Fortreſſe *Hexagonall*, let EH be 60 rodd, and EI, BC, KH equall, the flanke KC 8 rodd, it behoues us to finde out the reſt.

BY the help of the rule of *Algeber*, ye ſhall finde that the angle EIF wilbe 69 degrees, 4½ minuts; then in the triangle IBC, the angle I, & the ſide IB 8 rodd being giuen, ye ſhall finde BC 20, 9229 for the face EI; alſo IC wilbe 22, 4002, then EC will make 43, 3231, the reſt is eaſie, without the ſecond flanck.

The 15. Figure.

This figure hath for the flanke 10 rodd; the reſt being like to the former they ſhalbe put in order in the Tables following.

The

The 16. Figure. & 5. Plate.

The flanke of this *Heptagone*, that is, A Fortreſſe with ſeuen angles, or Bulwarks, maketh 10 rodd, the diſtance of the points 72 rodd, and the angle flanked 80 degrees, how many then will the reſt make, when as the ſecond flanke is 10 rodd.

SEing that the angle of the Bulwarke makes 80 degrees, and the angle of the *Polygone* 128: 34, 17 the difference divided in the halfe wilbe the angle flanking interiour 24, 17, 8½, the flanck CB 10 rodd, whence the triangle CBG wilbe knowne, & by adding GH giuen to BG, ye ſhall haue the curtaine 32, 1623, which taken from DP 72 rod, and then take the halfe of the reſt, ye ſhall finde DF, and alſo DC. CF, for the face DC 21, 8525, & DG 46, 1666, alſo in the triangle DAE, ye ſhall haue DE, & conſequently EF, or AB. Moreouer ye ſhall finde DH in the triangle DKH, to be 55, 4345.

The 17. Figure, & 5. Plate.

This *Heptagone* hath the flanke of 9 rodd, the angle flanked 79 degrees 25. 43, DP 72 rodd, and the choice of the ſecond flanke.

ALB. GIRARD.

HAuing calculated the angles as in the former, OM wilbe 21, 6436, and HM, 19 6836, let us make the ſecond flanke 7, 3164, and then the curtaine wilbe 26; DF, 23; the face OP 25, 2901. MP 46, 9337. *Marolois* had giuen here 80 degrees, but tooke no more then 79, 25, 43, for the angle flanked, which he did without premeditation.

The 18. Figure. & 5. Plate.

In this preſent *Heptagone* the angle flanked is 79 degrees, the gorge 12 rodd, & the curtaine 32 rodd, how much will the other lines & angles make of this Fortreſſe.

TO reſolue this queſtion, ye muſt ſuppute from the triangle CBG, the lines CG, GB, and ye ſhall haue GB the ſecond flanke; now if to BG, ye add AB, ye ſhall haue AG, then the triangle DAG wilbe knowne, afterward the triangle DAE, and finally the triangles DCF, and DHK.

ALB. GIRARD.

NOte that in this Queſtion *Marolois* had ſett downe the angle flanked 79 and 2 ſeuenths, yet did not followe this number, but 79 degrees: the ſame errour alſo was committed in his ſupputation of the former, and in the 14 figure. One cannot geſſe well his Suppoſition: neuertheleſſe that needes not to ſtay the reader; for I haue ſett downe the queſtion, as it ſeemes he would haue propounded it, but the

17451.

the worſt is, he made 2 figures, and one cannot underſtand well of which of either of them he would ſpeake, but we will ſpeake more thereof hereafter; howſoeuer thoſe which are moſt intricate (aſwell by reaſon of the faults eſcaped in the impreſſion of the former Editions, as by the errour of his diſciples, which did calculate them) ſhalbe partly omitted, and ſhall giue no impediment, but that the reſt may giue contentment to the Readers, for that which they are deſirous to finde out in this booke: (in the 20 figure following the Letters ye were ſent unto were wholly repugnant.)

The 19. Figure.

In this *Heptagone* let the angle flanked be 80 degrees, & the angle from the Capitall line, & from the imagined DB (to wit ADB) let be 22½ degrees, DP 82 rodd, & the flank CB 10 rodd.

FRom the angle of the *Polygone* 128,34,17, take the flanked 80, the halfe of the remainder wilbe 24,17,9: for the angle flanking interiour DGA: beginn then the triangles CBG, DBG. (whereof the angle in D maketh 17½) ye ſhall finde BG 22,1621, CG 24,3138; & BD 30,3118, then GD wilbe 49,1096, and DC the face 24,7958, afterward the triangle BDF, the line BF wilbe found to be 20,1982, and DF 22,6014, whereof the double taken from DP 82, there will remaine for the curtaine BH 36,7972, and conſequently for the ſecond flanke GH, 14,6350. Now knowing the triangle DEA, ye ſhall finde the Capitall, alſo the gorge AB 12,8744. If in the triangle DKH, yee ſeeke DH, then ye ſhall finde it to be 62,7388. Now the reaſon of the Demy-diameter or middle line in the ſide of this *Heptagone*, is as 1000000000, to 867767478.

The 20. Figure.

This preſent *Octogone*, that is a Fortreſſe of 8 angles or Bulwarks, hath the diſtance DP divided into 7 equall parts, whereof DF, & FB make each of them 2, & BP fichant is 60 rod, the angle flanked 82½ degrees.

THe line BF being 2, and FP 5, then the ſquare of BP wilbe 29, and ſeing that BP is 60 rodd, its ſquare wilbe 3600 rod, by which reaſon ye may knowe one part of the 7 of DP, ſaying, if 29 giues me 3600, how many will 1 giue me (the ſquare of an other part?) it will come to 124, 1379310345, whereof the ſquare roote ſubſtracted wilbe 11, 14172, and its double 22, 28344 for DF, or FB, the triple is 33, 42516 for the curtaine BH, and the ſeventhfould 77,99204 for DP. Moreouer, the angle flanking interiour, or its equall FDC wilbe 26,15; ſo that DC wilbe 24,84581, alſo FC 10, 98907, the flanke then wilbe 11, 29437 (for FB was knowne) in the triangle right-angle DRG, the angle D is alſo 26. 15; and RC equall to FB, then DG the line of defence flanking, wilbe 50,38218; finally, the Capitall wilbe found 24,11937, and the gorge AB 13, 05342, if ye calculate the triangle DEA.

The 21. Figure.

In this *Octogone* let the face be 24 rod, the flanke 12, & the curtaine 36 rod, & the angle flanked, right, it is required how many the other lines & angles wilbe?

The

The angles ADF 67½, & ADC 45, will make knowne CDF to be 22½. Now DC is 24 rod, by consequence DF, FC, DP, FB wilbe knowne; also seing that FB is found (or EA) ye haue also the triangle DEA, by which ye shall finde DA, AB, & shall finde DG in the triangle CBG: (for hauing CG, ye add unto it DC) finally DH in the triangle DKH.

DP	80,	34624	GH	7,	02948.
DG	55,	35756	AB	13,	39837.
DH	61,	91032	AI	62,	39837.

The 22. Figure.

In this present *Octogone*, the flanke is 11 rod, the angle flanked 82½ degrees, the line DP 76 rod, & the second flanke to be chooſen, how many then wilbe the other parts of this Fortreſſe?

THe angle of the *Octogone* is knowne, and the angle flanked, also their halfe ADF, ADC, therefore the reſt, and the triangle CBG wilbe knowne, and BG wilbe found 22,3058, ſuppoſe the ſecond flanke GH is 9,6942, then BH 32 rod, likewiſe as much for FK; but DP is 76, therefore DF makes 22, and after ye haue calculated the triangles DCF, DAE, ye ſhall finde DC, 24,52978, DG 49,40045, AB 12,94981, and finally in the triangle DKH the fichant DH, 58, 25283.

The 23. Figure.

Let the angle flanked be 82½ of this preſent Octogone, the line of defence DG 50 rod, DP 76, and CAB the halfe of the angle flanked.

AFter ye haue carryed AC, which was forgetten, if ye count the triangles DAG, ACG, ye ſhall finde the Capitall, the face, and the gorge, and BG, then the triangles CBG, DCF, afterward ye ſhall haue CB, CF, DF, and therfore FK, or the curtaine, and the ſecond flanke, then DH, 58, 3498.

The	Capitall	23,	93655	The	ſecond flanke	9,	15324
	Gorge	12,	84323		face	24,	53340
	Flanke	11,	26362		Curtaine	31,	99346

The 24. Figure.

Let there be an *Enneagone*, A fortreſſe with nine Angles or Bulwarks, (that is with 9 ſides) whereof the angle flanked is 85 degrees, the face 24 rod, the flanke 12, and the curtaine 36 rod.

THe angle of the *Polygone* is 140 degrees, ſeeke the triangles, DCF, CBG, DEA, DKH, and then ye ſhall finde the lines GH 12, 94824: DP 78, 57648: AB 12, 88709.

The 25. Figure.

As in the tables aboue let the angle flanked of the Enneagone be 85 degrees, the fichant 60 rod, and DP being 7 parts, then let DF be two of them, afterward FB the perpendicular 2, for the makeing of the flanke CB, wee require the reſt.

DK being 5 parts, and KH 2. the ſquare DH wilbe 29. which makes 3600, whereof 1 makes 124, 13793103 for the ſquare of one part, its root ſubſtracted wilbe 11, 14172 for one part, whereof the double wilbe for DF, or FB, and the triple for FK, or the curtaine 33, 42516 BH, and after ye haue calculated the triangles DFC, CBG, DEA, ye ſhall finde the other lines DC 25, 1219, DG, 48, 25855, GH 12, 9026, BC wilbe 10, 68335, the ſeuen parts of the number aboue ſayd wilbe for DP, 77, 99204.

The 26. Figure.

In this preſent *Enneagone*, let the angle flanked be 85 degrees, the defence 50 rod, the other 60, & the gorge in the flanke as 4 to 3. the reſt is required.

IF ye take away the angle ADC 42½ from ADF 70, the angles GDR will remaine, and DG makes 50 rod, then the triangle DGR wilbe knowne, to wit, DR, & RG, or KH 23. 0875, which will make ye knowe the triangle DKH (for DH is 60) then RK, or GH wilbe 11, 0301. Moreouer, in the triangle DEA the ſide EA is equall to KH, by DE & DR, ye ſhall haue AG 35, 94735, then in carrying AC, ye ſhall ſeeke the angle A from the triangle ABC, ſetting downe AB 4, and BC 3 parts, according to the *Hypateſe*, ye ſhall finde then the angle A of 36 degrees, 52 min. & 12. ſeconds. Then let us goe to the triangle ACG, hauing AG knowne, the angle A & G, equall to CDF 27½ degrees, to finde CG afterward the face, and conſequently DF, FK, EF or AB the Gorge, which wilbe 14, 72808, therefore if 4 giues 3, how many then AB? ye ſhall haue BC for the flanke 11, 04606, & DP 78, 51183, DA 24, 56925.

The 27. Figure.

The diſtance DP being 7 parts, DF & FB each of them 2 parts, the defences 50 & 60 rod, and the angle flanked 85 degrees, how many will the other dimenſions be of ſuch a Fortreſſe non angular?

ALB. GIRARD.

THis queſtion is impoſſible to reſolue being exceeding, ſeing that there is a condition in it more then one deſires, & vvhich is vvorſt, repugnant to the others, for vvhich fault the Authour may be excuſed, ſeing that in his time, there vvere no ſuch advertiſements giuen as vvee haue giuen thereof in the beginning of the Trigonometrie, *cited in the firſt queſtion going before, the vvhich though they may ſeeme to be of litle conſequence to ſome; yet one muſt acknovvledg, that thoſe that knovve them ſhall not fall into the like errours, as theſe vvhich may be explained thus; There are tvvo reaſons giuen* DP *to* DF, *and* DF *to* FB *(a reaſon of equality)*

equality) two lines of defence the angle flanked, & the name of the figure of nine-side figure, which are sixe termes, yet one needes but 5 (as ye shall finde it noted in the 7 figure, where the question was defective, and of some others afterward) finally, the proofe of this may be seene in makeing comparaison of this with the 25 figure, where the same question is propounded, and where ye shall finde that the defence flanking ought to be 48,25855, and here he will haue it 50, which is absurd, as is said.

The 28. Figure.

In this present *Decagone*, a Fortresse with ten angles or Bulwarks, let the angle flanked be 87 degrees, the Gorge in the flanke in reason sesquitertia, the defences 50 and 60 rod, it is required how many the other parts thereof will make?

THe reason *sesquitertia* is, as 4 to 3, for AB to BC, then the imaginall angle BAC wilbe 36 degrees, 52 minutes, 12 seconds. Moreouer, the angle ADC being 43½ then CDF wilbe 28½, which is an angle of the triangle GDR, and which may be knowne, seing that DG is 50 rod, therefore GR 23,858, or its equall KH, and for as much as DH is 60, then DK wilbe knowne, and also DR withall, and so ye shall finde RK for the second flanke: likewise the triangle DEA wilbe knowne, then ED and DR will make knowne ER, or AG, & consequently ye shall haue the triangle ACG for the angle A was found aboue, and the angle G is 28½ degrees, then the face wilbe 26,11334, and hauing found out DF, ye shall finde EF, or the gorge 15,197: Also FK for the curtaine 32,10821; DP 78,00619.

The 29. Figure.

In this *Decagone* the angle flanked maked 87 degrees, the defence fichant 60 rod, the flanke 12 rod, and the gorge 16 rod, it is required how much the other parts make?

THe *quadrangle* ABCD hauing fiue termes giuen, ye shall finde the other parts; also the triangle DFC, whereby ye haue FB, or KH, & consequently the triangle DKH, and hauing FD & DK, their summe and difference wilbe for DP, 78, 65, and BH 30,32633; the face shall be 27,49377: DG 52, 64265.

The 30. Figure.

In this *Decagone*, let the curtaine be 36 rod, and the flanke 12, the face 24, and the reason of the Bulwarke in the flanking interiour, as 58 to 19.

THe halfe of 58 is 29, then the angles ADG to AGD, or CDF, wilbe as 29 to 19, therefore setting downe ADF to CDF, it wilbe as 48 to 19; but ADF is 72 degrees, then CDF wilbe 28½ degrees, & then the angle flanked 87 degrees, the rest is easie, for the triangles DCF, CBG will make knowne CF, FD; DG is 49,14888, DH 61,68324; DP 78,18336, AD 24,52336.

The 31. Figure.

Let there be a *Decagone*, whereof the face is 24 rod, the flanke 12, and the curtaine 36, how many will thoſe parts make, when the defence flanking is doubled to the Capitall.

IF DG be ſett downe 2. then DA wilbe 1. Now the angle DAG is 108 degrees, then the angle flanking interiour G wilbe 28. 23. 38, and the angle flanked 87, 12, 44, the reſt is eaſie, & is found in the ſame manner, as the end of the former, & therefore *Marolois* leaues its ſo for this reaſon.

The 32. Figure.

In this preſent *Undecagone*, a fortreſſe with eleuen Bulwarks, let the face be 24 rod, the flanke 12, the curtaine 36, and the capitall DA to AG as 5 to 7, the unknowne parts are required.

SEt downe DA 5, and AG 7, and the angle DAG is 106 degrees, and 4 eleuenths: that is 106, 21, 49, and hence ye ſhall know the angles remayning ADC, 43, 55, 48, and the other or CDF 29, 42, 23, therefore in the triangle CDF, the angle D is then ſo, and DC 24 rod, and then DF, DK, DP wilbe knowne, likewiſe FC, FB, BP, & AD, DE & EF for the gorge. Here is nothing but that which is ill calculated by the Autheur, or rather by his diſciples, as from the beginning (without all doubt) ſeekeing to help themſelues with the figure put here under, which was needleſſe; ſuppoſing that they had ſkill in *Trigonometrie*. I will onely ſet downe here the reaſon of the raid (or ſemy-diameter) in the ſide of the *Vndecagone* inſcribed in the Circle, is

as 1000000000000000
to 563,46511368285.

So that ye may take here the reaſon or proportion as preciſely as ye will.

The 33. Figure.

In this *Undecagone* let the face of the curtaine be as 2 to 3: & the gorge in the flanke as 4 to 3, the diſtance of the points of the Baſtions 75 rod, and the angle flanked 88 degrees, 38 min. 11 ſeconds, the queſtion is how ye ſhall finde out the other dimenſions?

SEing that ADC, and ADF are knowne, the reſt CDF wilbe alſo, being 29, 19. 6, & ſetting downe DC 2 parts, (then the curtaine, or FK wilbe 3) the triangle CDF wilbe knowne by the parts, namely DF 1, 74384, as much alſo is KL, and FK 3, then DP wilbe (in parts) 6, 48768, which make by the Hypoteſe 75 rod, & by this reaſon, ye ſhall finde out the face, and the curtaine, ſaying, if 6, 48768 parts make 75 rod, how many then will make aſwell 2, as 3? DC 23, 12075, & BH 34, 68112 as much makes FK, which taken from 75, the halfe of the reſt wilbe for DF, ye ſhall finde then alſo FC, afterward AB, being ſet downe upon 4. BC wilbe 3, then the triangle BAC wilbe 36, 52, 12; which taken from DAB, there will remaine DAC, & ſo the triangle DAC

ſhall

ſhall haue 3 termes, ye ſhall then ſeeke DA, or AC, by which ye ſhall come to haue AB 13, 7969, & BC 10, 34743, then in the triangle CBG, ye ſhall finde BG, afterward DR, or CG being knowne ye ſhall haue DG 41, 54579, GH 11, 57396. and finally DH the fichant 58, 96636.

The 34. Figure.

Moreouer for this *Undecagone* let the angle flanked be 88 degrees 38, 11, & the face to the curtaine as 2 to 3, and the gorge in the flanke as 8 to 5. & the fichant 60 rod, how many will all theſe lines make?

YE muſt firſt finde out the *Quadrangle* ABCD, whereof the angles are knowne, & ſett downe AB, 8 parts; then BC wilbe 5, & DC being found, ye ſhall finde DF, FC, alſo BH, ſeing that DC is to BH as 2 to 3; hauing DK, and KH ye ſhall haue DH in parts, which make 60 rod, by which reaſon ye haue the lines required, AB, 14, 6, CB 9, 127, DG 42, 374, DC 23, 7363, BH 35, 604, & DP 76, 99675.

Vpon the 35. Figure.

ALB. GIRARD.

THis queſtion is defectiue, in regard it hath but foure termes knowne, DP 70 *rod, &* CB 10, *the reaſon of* DC *to* BG *is as* 10 *to* 9, *and the name of the figure* Undecagonall, *which are but* 4 *termes, he comes to the conſtruction, ſetting downe the face* 20 *rod, to ſee if there be not in it repugnancie, as if the queſtion were exceeding, ſo that he in this ſearch committeth the faulth, which is called* petitio principij. *Which is ſpoken not to defame the Authour, but to ſhew, how this proceeded from hence, that in this time many thought that* Geometrie *hath attained to her higheſt degree; though wee haue had but the* A, B, C *of it: till that ſome undertakeing the reſtauration thereof, haueing in part made it flourish againe, could neuertheleſſe eſcape the blame of ſome enuious & ignorant men in this diuine ſcience, as happens often, haue let paſſe the moſt difficult of the* Analitica, *which ought to adorne thoſe, that make profeſſion thereof, who contrarywiſe ſetting downe the limits of their pretenſions from the beginning of their courſe; by emulating one an other, content themſelues to grope together without learning to goe forward with a ſolide, and a firme pace in a faire way.*

The 36. Figure.

In this *Dodecagone*, let the face be 24, the flanke and the curtaine 36 rod, the angle flanked right, how many will the remayning lines make?

LEt DF be found, alſo FC, ye ſhall haue DK, & KH for to haue DH, afterward in the triangle DGR, hauing the angles & RG, ye ſhall finde DG. Finally ye ſhall finde DE in the triangle DEA, for to haue EF, or the gorge: Now ſeing that GCB is 60 degrees, then of neceſſity GC wilbe 24, as being aſmuch againe as CB, then DG wilbe 48, and GR, or KH the halfe is 12, therefore DH wilbe 61, 648, DP, 77, 56944.

17451

The 37 Figure.

In this preſent *Dodecagone*, let the angle flanked be right, the defences flanking, & the fichant 45, & 60 rod, the gorge in the flanke is as 4 to 3.

SEing that the angle DCF is 60 degrees. DH 45 wilbe the double of GR 22½ rod, DH, HK being knowne, DK wilbe 55, 621, DR 38,971, then the ſecond flanke 16, 65. Alſo DE wilbe found by the triangle DAE, & taken from DR, there will remaine AG the baſis of the triangle ACG, the angle A thereof wilbe 36, 52, 11, becauſe of the reaſon giuen, and G 60 degrees, then the ſayd triangle ACG will make knowne CG 21, 4933, & alſo the face 23, 5067 (for DG is 45) the halfe of GC is CB 10, 7466, which multiplyed by ⅓, ye ſhall haue BA 14, 3289, DP 75, 979, BH 35, 2637.

The 38. Figure.

Let the curtaine be 36 rod, the line of defence flanking 45, the angle BAC 36, 45, & the flanked right. How many will the other parts of this Fortreſſe *Dodecagonall* come to?

THe triangle DAG, afterward ACG wilbe knowne, and alſo CBG, DCF, DKH, whereby DC wilbe found 23, 974, GR 22½ (the halfe of DG) 10, 5127, DH 61, 0593. DP, 77, 52516, AB 14, 733.

The 39. Figure.

In this *Dodecagone* the angle BAC makes 37 degrees, the flanked right, the face 24 rod, the fichant 62, how many makes then the other lines?

THe line DC 24 ſhalbe the double of CF 12; the angle BAC being giuen, the triangle DAC, wilbe knowne, therefore DA, AC, and the triangles DAE, ACB DGR, DHK wilbe knowne; and conſequently the lines required, as AB, 14, 6179. BC, 11, 01525, BH 36, 7851; DP 78, 3547. DA 23, 82709; He failed herein to calculate them a new together: but the reaſon of this was, that wee agree not, ſeing that in the conſtruction, in ſtead of 37 for the angle BAC, (as he ſett downe) he tooke 38.

All queſtions comming after this are defectiue euen to the diſcourſe, which endeth the order of the ſame queſtions; but ſeing I know whither it tends, I will explane them, in adding thereunto the things, that were wanting paſſing ouer the figures 40, 41, and ſo we will beginn with the 42, as followeth.

The 42. Figure.

In a ſquare Fortreſſe with foure Bulwarks, let the angle flanked be 60 degrees, the angle forming the flanke FID 40 degrees, the face 24 rod, hauing the reaſon to the curtaine as 4 to 5, the other lines are required.

Seeke

Seeke the triangles DAL: AID, IFD, DFP, ye ſhall finde alſo PH, for FH wilbe 30: 1048, 45532: AK 76, 6464, IF 9, 22766: FD, 7, 74298, IA 19, 73479, the fichant AH 54, 98265.

The 43 Figure.

Is a *Pentagone*, the angle flanked 69 degrees, the angle forming the flanke 40 degrees, the curtaine to the face as 5 to 4, the face 24 rod; wee deſire to know the other lengths.

Ye muſt doe as before, and then there wilbe no difference in the operation, Touching the number of the names of the figures in this 9 plate, ye ſhall finde them marked about the angle flanking exteriour, the reaſon of the face to the curtaine is marked on the point of the Baſtions, the length aſwell of the face, as of the curtaine next themſelues, and muſt be propoſed as the two former, hauing alwayes the angle forming the flanke of 40 degrees: the opening of the flanked angles, is according to the manner of the firſt table, to wit 15 degrees more then the demy-angle of the *Polygone*, ſauing that in the figures 2, 43, & 2, 44, afterward an other time the 45, 46, he taketh for the angles flanked the $\frac{2}{3}$ of the angle of the *Polygone*, according to the ſecond table in the beginning placed before: Of theſe things ye ſhall finde 2 tables in the end of this booke, ſetting downe the faces to the curtaines, as 2 to 3, the faces 24 rod, which make the former-flankes 40 degrees, and the flanked according to the two manners aboueſaid, where ye muſt knowe, that the lines of defence fichant are about 60, 61 rod. The ſaid tables are both calculated anew; becauſe of the errours eſcaped in the other editions. Moreouer, after the *Dodecagone* ye ſhall haue ouer and aboue following a Fortification upon a right line, which is called upon a right curtaine. Now let us marke what the Authour ſaith.

Note 1.

NOw not to take ſo much paines in remembering the diverſe proportions of the face to the curtaine, whereof the Fortreſſe *quadrangular*, & *Pentagonall* Fortreſſe is as 4 to 5, and the *Exagonall* as 3 to 4, it will not be amiſſe (ſeing that the line of defence will beare it) to make alſo the ſaid Fortreſſes of the ſame proportion, as the ſubſequent, to wit, in reaſon *ſeſquialtere*, as appeareth by the 3 figures of the 9 plate, quoted by the numbers 2, 42. 2, 43. 2, 44. where the lines of defence doe not much exceede 60 rod, which is as farre as a muſket can well carry, & therefore one ought not to exceede this number; becauſe that alwayes from the flanke reciprocally the entrance into the moate muſt be defended, which is often done, and moſt commodiouſly by the Muſkettiers, becauſe that Canon cannot ſo ſuddenly (by reaſon of the weight) be brought thither, many good occaſions are neglected, for which cauſe they are preferred before Canon, and in regard a Muſket will but carrie ſome 700 feete point-blanke, Bulwarkes ought to be made noe further one from another, for otherwiſe the line of defence would be too long, which ſhould cauſe imperfection.

Note 2.

IF in ſtead of takeing the face 24 rod, for the line of the *Polygone* exteriour take 80 rod, and the reſt according to the former proportion, the parts wilbe brought very neere

neere together, as appeareth by the precedēt Examples, according to the figures of the 10 plate, marked with the numbers 51. 52. 53. 54. 55. 56. 57. 58, 59, whereof we haue made no calculation; becauſe they are eaſely done by the former ſupputations.

Note 3.

THat in all our deſignes and calculations, we are reſolued to uſe but one meaſure onely, which is in the 25 plate of our *Geometrie* upon the rule of the inſtrument marked number 1, which is a foote deuided into 12 equall parts, whereof 12 foote makes a *Rheneland* rodd in the territoire of *Leyden*.

Deſignes & plat formes of diverſe Fortifications.

WE might according to the former ſupputations giue diuerſe conſtructions of the platformes of Fortifications; but conſidering the great diverſity of rules, (which often cauſes confuſion, and that time will not permit us) wee will giue but one ſimple and generall rule for them, which is this following.

The 9 Plate, and the 42, 43, 44, 45, 46, 47, 48, 49, 50 Figures.

FIrſt, if the face be giuen (ſuppoſe it to be 24 rod) then ye muſt doe as followeth: Ye ſhall draw a right line infinite AC from the point A, the angle CAB ſhalbe made according to the forme of the *Polygone*, upon which A, B ſhalbe ſett downe the 24 rod abouesayd, as from A to D, and by D is drawne the line, which formeth the angle of the Center of the Bulwarke 40 degrees, then muſt ye ſett downe upon A, C and A, B, the reaſon of the curtaine to the face that by the ſame ye may draw the line infinite A, E, makeing from the point D, a parallell with A, C, cutting the ſaid AE, at G, by which point is drawne the line, that formeth the other face G, K, in ſuch ſort that the angle G, K, A, wilbe equall to the angle D, A, K, and ſo the figure wilbe drawne, according to the ſaid proportion.

The 10. Plate, & the 51, 52, 53, 54, 55, 56, 57, 58, 59, Figures.

SEcondly, if the line from angle to angle be giuen AB (for example 80 rod) ye ſhall then proportion out the face to the curtaine *ſeſquialtera*, as 2 to 3. Then in conformitie of the table of angles ſet downe before, wilbe made the angle CAB, according to its forme, to wit, in a ſquare of 15 degrees, in a *Pentagone* of 89$\frac{1}{2}$ degrees, in the *Exagone* 22$\frac{1}{2}$ degrees, and ſo conſequently of the reſt, then for the forming of the abouesaid proportion of the face to the curtaine, which is (as we haue ſaid) as 2 to 3. aſwell in a ſquare Fortreſſe as in a *Pentagone*, and others following ye ſhall take upon a ſcale of a reaſonable greatneſſe 2. which ſhalbe ſett from A to C, and 3 from A to D, ſuppoſe that it be at C & D, then from the point D wilbe made the arch G of the diſtance of 2, (to wit CA) & from C of the diſtance of D, A, 3, wilbe made the arches, which cutt betweene each other at G, by which a right line being drawne to A, where the ſame cutting the line FB, as here at F ye haue the face of the Bulwarke, and by that the curtaine wilbe knowne. To knowe alſo the line of the gorge, and the flanke, and all the other parts, ye muſt make the angle forming the gorge, and the flanke of 40 degrees, as is here the angle KIE, cutting the diameter P, A, at I, from which point I. a right line parallel being drawne from A, B, as is I, N, ye ſhall drawe the line perpendicular to be E, K, which ſhalbe the flanke, and K, I, the line of the gorge of this Fortreſſe, and then ye haue the thing required.

In

In like manner ye ſhall finde, and marke out the other Fortreſſes, according to their ſeuerall formes, takeing heede that as here ye take 2 & 3, ye muſt in the others alſo take 2 & 3, to place them aſwell upon A, B, as upon A, C, and the reſt being the ſame; as is in the former conſtruction it wilbe needeleſſe, to giue yow here any further particular inſtruction for them.

The 3, 50. Figure, and the 9. Plate.

ALBERT GIRARD.

'I'Hirdly, VVhen upon the line of the Polygone *interiour AB, ye deſire to conſtrue, or explane a Fortreſſe, hauing 5 termes, to vvit, the name of the figure, the angle of the baſtion M, The angle forming the flanke GBH, and the reaſon of the face DG, to the curtaine HL, conceiuing therein that AB is giuen.*

This figure is in ſtead of the 2, 50, being vvorth nothing. I am ſo conſtrained to make a nevv figure, and a nevv explanation. Let then NBA be equall to the demy-angle of the Polygone, *and let the angle forming the flanke be HBG, LAK, ſo ye ſhall haue the interſection or cutting betvveene C, then DBF the halfe equall to the demy-angle flanked, and finding the point F, ſo that AB, to BF is the reaſon of the curtaine to the face, and hauing dravvne CF, cutting NB at D, and makeing DG a paralell vvith FB, meeting vvith BC, at G, ye haue finally GH the perpendicular vvith BA, and doing the like alſo on the other ſide, ye ſhall haue all the parts required; the demonſtration is manifeſt, ſeing that C is the common point of the like figures FBA, DGK: then as FB, to BA: ſo DG the face, vvilbe to GK, or HL.*

The 11. Plate, and 60, 61, 62, 63, 64, 65. 66. 67, 68. figures.

IF there be a queſtion to proportion out the face to the curtaine, and the gorge to the flanke, when the line EF is giuen, ye ſhall doe as the figures in appearance demonſtrate to the eye, namely, ye ſhall firſt proportion out the face to the curtaine by the former rules, and make it ſoe that the curtaine of a ſquare Fortreſſe be 300 foote, and the face HF, 250 foote, hauing reaſon as 5 to 6, according to which ye ſhall finde the point G, which is the angle of the ſhoulder. To finde then afterward the gorge & the flanke, ye ſhall make the couert line GH, which muſt be diuided into 4 equall parts (in foure, becauſe ye would haue the reaſon of the gorge in the flanke as 4 to 3) whereof ye muſt place three of them from H to I, and then drawe I, G, cutting through the *ſcmy-Diameter* of the *Polygone*, which is here ſquared into A, and then the line AB being drawne it wilbe parallell with EF, and ſo ye haue the ſide of the *Polygone* interiour, upon which the 2 perpendiculars being drawne GC, HD, ye haue the 2 flankes, and conſequently the eſſentiall parts of a ſquare fortification knowne: ye muſt alſo obſerue the ſame in the other figures following.

If the line EF, which is the ſide of the *Polygone* exteriour (or the diſtance of the angles of the Bulwarks) be not giuen, but onely the line AB, the ſide of the *Polygone* interiour, ye ſhall ſeeke out in the tables a Fortreſſe of ſuch a forme, whereof the face to the curtaine is as 5 to 6, and ſhall worke it by the rule of proportion, *or elſe let it be made after the former manner, vvhich is much more eaſie, then all the figures of the* 11. *Plate.*

If ſuch a ſide of a *Polygone* interiour, giueth ſuch a ſide of a *Polygone* exteriour, what will ſuch a ſide interiour giue? & ye ſhall haue the thing required; to wit, the *Polygone*

17451

exteriour, whereby one may easely know the other parts of the Fortresse, when the line AB of the *Polygone* interiour is giuen. But if in the tables the proportion be not found, make first upon the line AB the triangle ARB, whereof the halfe of the basis hath the like reason to the perpendicular, as ye will haue proportioned out the gorge of the flanke, demonstrated by this exemple as 4 to 3, which wilbe done in setting downe upon the said line AB foure equall parts (4 because ye desire to haue proportioned out the gorge to the flanke, as 4 to 3) to wit from A to D, raising out of the point D a perpendicular, and put 3 of the said parts from D to I, then doing the like on the other side, by this meanes wilbe formed the triangle ARB, and from the points A & B, the angles flanking interiour wilbe made according to the forme of the *Polygone*, (which is a *Pentagone*) conformable to the table of angles described heretofore, as appeareth by the letters SBA and TAB, which cutt the lines infinite A,L. L,B at the points S,T, and the line S,& T being drawne, the angles T,S,B, and S,T,A wilbe equall to the angles S,B,A, and T,A,B, as appeareth by the 28 proposition of the first part of *Euclide*.

According to which the reason of the face being putt to the curtaine, upon T,S, and T,A, namely, the face upon TA, and the curtaine upon T,S; ye haue the like distances, and from the points I & X, the arches which cuts betweene them in a certaine place, by which intersection the line T, V, shalbe drawne cutting the line S,B, at V, then the right line V,L. being drawne passing through the center L, & cutting A,R at G, ye shall haue all the parts of this Fortresse: for hauing sett downe the distance R,G, from R to H, from the same point G is drawne a paralell to S,B, as E,G, cutting the *Diagonall* line L,A, at E, the like ye shall finde for F, and consequently all the other parts of the said Fortresse *Pentagonall*. The same must ye also understand of the other figures following, from the figure 60, to the figure 68. Also ye may finde the point V, in setting downe upon T,A, 2 equall parts, such as ye require, and from the extremity or utmost end, hauing made it a parallell to S,T, and upon the same, 3 of those parts, and drawne from the extremity the line TV, the said point will consequently be knowne thereby.

NOte that the proportion giuen here, betweene the face and the curtaine is not so much to relye fast upon it, as to show that the generall rule sett downe here before in the 9 and 10 plates, take place also in all other reasons, which may be propounded. For otherwise wee are of the opinion; that the former figures would rather be accepted then these here, because that the reason of the curtaine to the face is (as wee haue said aboue, sesquialtera as well in square Fortresse, as of *Pentagonall*, and others following. Which for the facility, & simplicity together with the goodnesse of them ought to be preferred before the figures 60, 61, 62, 63, 64, 65, 66, 67, and 68, of the 11 Plate aboue said. Whereof the face to the curtaine is (as the exemples shew) of diuerse reasons; in such sort, that hence forward one ought to resolue, that the reason of the curtaine to the face ought in all formes of Fortification to be *sesquialtera*, and the face 24 rod, each rod containing 12 foote, the length whereof is sett downe in the 25 plate of our Geometrie, noted with the character or the figure 1, & is diuided into 12 ynches, which rod is used in the Fortifications of the United Provinces, to the end that the line of defence may not exceede much aboue 60 rod, which is about as farre as a Musket can well beare, the gorge to the flanke may be made by the rule giuen in the 11 plate, according to the reason giuen, but forasmuch as it is more convenient to make the angle forming the flanke GAC (plate the 11) of 40 degrees which giueth the reason almost as 6 to 7, in my opinion one ought to rest thereupon, and so ye shall haue a generall rule for all manner of Fortifications,

whither

whither they be *Quadrialtera*, *Pentagonall*, *Hexagonall*, or the others following, as ye may perfectly understand by that which shalbe said hereafter. In the meane while note that I giue here the reason of the gorge to the flanke as 7 to 6, which ought to be understood in Fortresses without Casemates, but if it were my intention to make some of them, I would then alter somewhat of the said proportion.

The manner how to describe succinctly the designes or Plots of some regular Fortifications.

The 12. Plate, and the 69. Figure.

ALthough one may (by that which we haue taught) sufficiently now understand the order, and Method requisite to be held in all manner of Fortifications: yet I haue thought it good to trace out here some from among the rest, to make the louers of this Art to conceiue the better my intention, and will begin with a regular *Pentagone*, whereof the angle of the center maketh 72 degrees, and the angle of the *Polygone* 108 degrees, and seing the angle flanked according to the table before mentioned, maketh 69 degrees: It wilbe easie to finde the angle C, A, D, which is alwayes equall to the angle flanking interiour, and shall finde the same to be 19½ degrees, setting then your graduate Instrument upon 19½ degrees, it makes the angle CAD, and drawing first the covert line infinite AB, takeing upon the scale 24 parts, or rod: and sett then from A to C, drawing from the point C a perpendicular upon A, B, as is CD afterward hauing sett on DE the length of the curtaine, which is here onely 34 rod (because the falsebrayes makes the lines of defence too great) & then the distance AD, from B to E, raysing from the E the perpendicular EF, being equall to D', C, and FB drawne out. the two faces wilbe knowne; for to knowe the center of the Bulwarke, shalbe made of 2 lines GA, & GB the Demy-diameter of the *Polygone*, then your instrument being sett upon 40 degrees, ye shall finde the angle HKA, cutting the said demy-diameter at the same point H: from which point the line HI being drawne; ye shall haue the side of the *Polygone* interiour upon which out of the points C, and F, shalbe drawne the perpendiculars CL & FM, which will forme the flanks, and the gorges of the said Fortresse *Pentagonall*, in the inside of the side of the *Polygone* interiour shalbe drawne a parallell of 5½ rod for the thickneesse of the rampart, as N, O N, R, and RS, and ye must draw for the parapett of the rampart a parallell of 20 feete (also in the inside of the said side of the *Polygone* HI) and on the outside thereof ye shall drawe a parallell of 20 foote for the falsebray as LX, and yet more outward 20 other foote for its parapet, & so all the other parts wilbe traced out, which are within the moate; for seing that there is here noe Casemates, the falsebray is carried not onely about the curtaines; but also about the flankes, and the faces of the Bulwarks, in such sort, that the falsebray serueth as a Casemats to the said flankes, the entrance or sallies ought in my opinion to be made in the midst of the curtaines, as covertly as possibly may be; the Bulwarkes are made either massiue, or hollow from Earth; at this present wee haue drawne them out as being hollow from earth, & so the superficies, or plaine in the midst of the bulwarke N, R, S, H. is of the same heigth, as the rest of the enclosure of the *Pentagone* is, the moate shalbe 10 rod broad, which is traced out as followeth: In the point A, or the angle of the Bulwarke, shalbe made an arch of the distance of 10 rod, & in the point V make an other arch of somewhat a lesser extention then the former about 10 or 12 foote, then drawe upon the back thereof a covert line infinite; the like must be done on the otherside of the Bulwarke, and so from place to place, with covert lines being

drawne as aboueſaid, the interſections of them will bring forth the angles of the ſaid moate, aſwell on the interiour as on the exteriour parts, ye muſt make upon the brinke of the moate exteriour a parallell of 20 or 24 foote; for the bredth of the covert way, and beſides ſomewhat more towards the exteriour part, ye ſhall make a parallell of 50 foote for the thickneſſe of the parapet thereof, which ſhall goe downe ſloaping being onely raiſed towards the covert way, or the Coridor of 6 foote, and diminiſhing litle by litle to the furtheſt part of the 50 foote, & ſo ye ſhall haue finiſhed the *Icnographia*, or ground-draught of this Fortreſſe *Pentagonall*, the ſtreets betweene the ramparts and the houſen ought to be 30 foote, that with the more convenience they may be entrenched in the time of neede, and that the ſouldiers may ſtand there in battle-ray. The ſtreets ought to be made of 24 or 30 foote, and for the market place every ſide ſhalbe made 12 rod, and of the ſame forme, as the *Polygone* is, which is fortified, being a *Pentagone*, in which the towne-houſe is to be made, & other publick buildings, & thus we haue finiſhed the forme thereof.

The 70. Figure.

THe *Profile* or draught ſhalbe made in this māner: firſt a privie line is drawne from the utmoſt part thereof, then ye ſhall beginne to lay out the breath of the ramparts, moates and wayes, & as wee haue ſett downe in our *Icnographia* for the bredth of the rampart 66 foote, which make $5\frac{1}{2}$ rod, we will take upon the ſkale joyned to the *Profile* 66 foote, for to place them upon the ſaid covert line as from A to B: then as the way of the rounds, which we otherwiſe terme the falſebray, is counted 20 foote, which one may take upon the ſaid ſkale, & remoue them upon the ſaid covert line, as from B to I, and the ſame 20 foote from I to M, for the bredth of the parapet, then ye ſhall make an edge MN of 6 foote, which is called in flemiſh the Teen, or the toe of the foote of the parapet, the better to prevent the falling of the ſame into the moate: from whence ye muſt take the bredth of the moate, which ſhalbe 120 foote; for ſo much makes the 10 rod as from N to Q, from Q to R, ye muſt drawe out 20 or 24 foote for the covert way, and from R to T 50 foote for the parapet; and ſo ye haue all the dimenſions required. For their heigths aboue AB ye ſhall make a parallell of 14 foote, which ſhalbe the height of the rampart, and underneath a parallell of 10 foote for the depth of the moate, the talud or ſlooping interiour of the rampart A, V, ought to be 14 foote, and the talud exteriour XB, muſt be the halfe of its heigth, which is 7 foote, and the trapeze, or unequall ſides giuen A, D, C, B, being the profile of the rampart: for its parapet ye ſhall take 20 foote from C to E, and from the point E draw a perpendicular of 6 foote, which ſhalbe the height of the ſaid parapet, and upon the ſaid perpendicular EG ſhalbe layd out 4 foote to drawe a parallell to DC, cutting the line B, H, at H, which ſhalbe the heigth of the ſaid parapet in this place, and for the ſuperiour part ye ſhall draw the line GH. Your foote banke ſhalbe made as followeth: from E is drawne the line FE of 3 foote, and $1\frac{1}{2}$ foote high, then from the upper part of the footebanke make the line G 2. in ſuch ſort, that the ſaid footbanke ſhall not be broader in heigth then 2 foote, and ſhall haue the talud 1 foote, which ſhalbe the talud interiour of the ſaid parapet. The parapet of the falſebray IM ſhalbe made as is aboue ſaid; to wit, from the point I, is raiſed the perpendicular 1K of 6 foote, which ſhalbe the height of the ſaid parapet, and from I towards B draw 3 foote for the footebanke, being a foote and a halfe high, and ſo drawe out the line K 2, that the bredth of the upper part of the footebanke be not (as wee haue ſaid) aboue 2 foote, in ſuch ſort that the Talud interiour (after ye haue drawne out the ſaid line K 2) of the ſaid parapet ſhalbe but a foote: for from the point I, the foote

banke

banke is 3 foote broad, but in the point 3 it is found to be but 2 foote broad. For the moate first draw out NO, which is the brinke interiour thereof, hauing the talud, as much as is the depth of the moate, to wit, of 10 foote, likewise the line Q, P, is taken, which is the brinke exteriour of the said moate, the parapet of the covert way Q, P, is made by rising from the point R, the perpēdicular line RS of 6 foote, takeing from the said point R towards the left hand 3 foote for the bredth of the footbanke, and to make it a foote and a halfe high; To giue the more firmenesse to the said parapet, there shalbe made from the upper part of the point S an oblique line upon the said footebanke, which is (as is before said) three foote broad; in such sorte, that the said line declining a foote upon the said footebanke, maketh the said footebanke to be noe broader then 2 foote. Finally a right line is drawne from S to T, which makes the slooping of the said parapet.

Note.

WE haue made the rampare no higher then 14 foote, upon the upper part whereof is made a parapet of 6 foot high, all upon a plaine field, which is a convenient heith for a place, that hath noe hils or heigths about it, but in case there be any hils, that doe commaund the said place, it wilbe then necessarie to raise the rampart somewhat higher, then is here described, answerable to the heigth of the said hill, which otherwise would commaund the Fortresse, & for the better blinding of such places, sometimes one makes upon the upper part of the rampart an other parapet about 7 foote broad, or there abouts & 6 foote high, which Parapet serueth so much the better to blinde the said place, and to discouver the fields about it, but when an Ennemy hath approched neere unto such places, then the said parapet can doe them no further seruice, so that necessity will compell them to take it away for their more safegard, and to lye under the said parapet of 20 foote broad: for Canon shott comming every time to pierce the said parapet being but 7 foote broade; they cannot safely lodge behinde it, without extreame danger; and therefore is necessary to be razed, to make use of the other, which is able to resist the force of Canon.

Wee haue not made here in this 79 figure any Ravelins or halfe moones, which are loose peeces on the further side of a moate, neither any Catts, or high platformes to plant ordinance upon, which are usually made in divers places within Forts, and upon Bulwarks; because we intend to speake of them hereafter. In the meane while it wilbe good to note, that the said Cats, Ravelins, and other workes, may be applyed to this present Fortification, but in this place is omitted for the avoyding of prolixity, because we are minded to treate of them briefly in an other place.

The description of the designe or the plate forme of a Fortresse Hexagonall.

The 13. Plate, and 71. Figure.

LEt there be giuen a Fortresse *Hexagonall* to be fortified, whereof the face AC maketh 24 rod, and the angle flanked 80 degrees, according to which the angle flanking interiour will make 20 degrees, and the exteriour 140 degrees, and let the curtaine be 30 rod, which giueth the reason of the face to the curtaine, as 3 to 4. To doe this, ye shall draw the covert line infinite, A, B, & by the helpe of an instrument

graduate, the other angle CAD of 20 degrees (of 20, becauſe that the angle flanking interiour, which is alwayes equall to it maketh here 20 degrees) by meanes of the line indefinite AC, upon which ye make the length of the face 24 rod, as from A to C, from which point C, the perpendicular CD being drawne upon the line A,B, ſhalbe placed from D, the length of the curtaine, which is here 32 rod as from D to E, finally the diſtance AD from E to B, and the perpendicular EF the diſtance of CD as from E to F, drawing the line FB, ye haue the other face, ſo that all the parts of the reaſon giuen are deſcribed; and for to finde the curtaine, ye muſt make firſt the angles GAB, & GBA of 60 degr. ſeing the whole angle of the *Polygone* maketh 120 degr. by the lines AG, GB, which cutting through on an other at G, is the center of the *Polygone*, and ſeing the gorge, when as ye would make caſemates in them or in a bulwarke where Cats or mounts are raiſed, they had neede of a larger extent, then otherwiſe; we ſuppoſe that it were requiſite, to make Caſemates in them, to that end we make the angle HKA, which otherwiſe might be but 40 degrees onely of 35, according to which the gorge in the flanke wilbe almoſt as 4 to 3, or ſomewhat more by reaſon of the line H, K, cutting the line *Diagonall* AG at H, from which point H the line HN being drawne, parallell to AB, ye ſhall haue the *Polygone* interiour, upon which the lines CL, and FM, being drawne in length the lines DC to L, and EF to M; in ſo doing all the eſſentiall parts of the ſaid Fortreſſe, wilbe deſcribed; Now to continew the ſame draught or platforme in every place ye ſhall make from the center G a privie circle from the diſtance GB, and ſhalbe ſett upon the privie circumference the diſtance AB, which being the 6 part of the ſaid figure *Hexagonall*, the ſaid circumference will contayne juſtly ſtill fiue parts, which finally will come to end at A. In the like manner is the privie circle made out of the ſame center G, and from the diſtance G,N, upon the circumference thereof ſhalbe ſet the line of the *Polygone* interiour HN, afterward ye muſt onely coppie out the reſt. Moreouer, the parapet wilbe 20 foote, which ſhalbe made in the inſide of ACL. MFB, and as the way of the rounds, or the falſebray, is on the outſide of the body of the Fortreſſe, we will make parallells towards the moate of 20 foote broad, & then 20 foote more for the parapet thereof, on the outſide of the parapet, before ye come to the moate, is made an edge, or a toe of 6 or 8 foote, to keepe the ſaid parapet from falling into the moate, which is made of 140, or 150 foote or thereabouts, as neceſſitie, and the bottome requires; for it muſt be fitted according to this conſideration, becauſe the ground lying lowe, it will not beare much digging before ye come to water, and therefore in this place one is forced to make the moate to gett earth enough for the rampart, but when the ground lies high, then ye may digg very deepe before ye come to the water, & ſo by this meanes ye may haue aſmuch earth, as poſſibly ye can well uſe, & ſeing without it cannot be but hurtfull, it wilbe better not to make the moate ſo broad, that ye may receiue noe hindrance or hurt by the ſtore of Earth that it affordeth; which may be caſt upon the outſide: For to beleeue that the ramparts being raiſed higher then the dimenſion giuen in the former figure to wit of 14; or at leaſt 15 foote, that they were better as ſome haue mainteyned, yet experience hath ſhowne many times the contrarie, for an ennemie hauing once approched to the brinke of the moate, the bredth of the parapet hinders one from makeing any defence upon it, which notwithſtanding is moſt neceſſarie: becauſe the neerer an ennemie comes with his approches towards us, we ought the more to defend our ſelues, and this being committed by our default, it is too manifeſt that one ought to take heede of it, and to remedie this errour by the former way: namely in makeing the rampart of the heigth aboueſaid. Some are of the opinion by a ſimple cōmaund that one ought to heigthen the ramparts aboue the ſaid 14 or 15 foote,

and

and not the Bulwarks, for which they haue ſome reaſon; for indeede the Bulwarkes make the greateſt defence, and when an ennemy is become maſter of the ſaid bulwarke, there were a meanes to cõmaund the ſaid bulwarke more abſolutely, ſo that an ennemy could not hinder the uſe of them, if he raiſed not his works aboue the ſaid rampart, to hinder the defences of the beſieged, which they might make with the ſaid ramparts ſo raiſed by a ſimple commaund, which in ſome manner might hinder the intents & approches of the beſiegers, the more eaſie would the entrenchements be made, and ſeing the more the bulwarks are raiſed, the more one ought to uſe diligence about the entrenchment; hence would follow this difficulty, that the comming to the rampart or the bulwarke, would not be ſo eaſie, as otherwiſe, neither could one make any great defence from ſuch ramparts by reaſon of their too much heigth, in ſuch ſort that one bulwarke ought to defend an other, & in ſuch a caſe the ſecond flanke would be of noe uſe after an ennemy is entred into the moate, at which time it is then moſt needfull to giue the greateſt reſiſtance that may be, ſeing that when they are gotten ouer the moate, and taken in the foot of the bulwarke, then the courage of the beſiegers begins to encreaſe, & the beſieged to faile them, for it is too apparant, that many times reſiſtance failes in ſuch and the like accidents.

Betweene two bulwarkes are commonly made ravelins or halfe moones, which are Quadrangular figures, euery face containing 12, 15, or ſometimes 20 rod, which beginn at the brinke of the moate: ſo that its angle interiour, or the tenaille O, lies juſt upon the brinke and angle of the moate, the reaſon why their faces P, Q, and Q, R, are made of a greater diſtance, is that the deffence may be the better: for otherwiſe their could be noe defence made but from one part of the face of the bulwarke, which otherwiſe would not be ſufficient to hinder the aſſaults of an ennemie, which ravelins or looſe peeces lie ſo open and are raiſed aboue the plaine field ſome foure foote, that one may the eaſier diſcouer the ſaid field, and ſo alſo to prevent the inconveniences which might happen, when one would giue fire from them upon the beſiegers, (if the ſaid ravelin had not bene raiſed) which would haue annoyed thoſe which were under the covert way. Upon the ſaid Ravelin being ſo raiſed, is made a parapet of 20 foote broad, and 6 foote high, which wilbe able to reſiſt Canon, the moate whereof ought to be made 50, or 60 foote, and as deepe, as poſſibly may be about the ſaid moate, ye muſt make alſo a covert way of ſome 20 foote broade, as hath bene noted before; Afterward ye muſt make a parapet of 50 foote broade & ſix foote high, ending at the end of the 50 foote towards the plaine field; as the profile doth ſhow in the 72 figure, and to the intent ye may the better underſtand my meaning, we haue made the ſaid *Hexagone* in perſpectiue, with the falſebrayes, Ravelins, covert wayes, and their parapets apart, as appeareth by the ſecond 71 figure, but ye muſt note, that the ſaid Ravelins muſt be in reſpect of Ramparts, which haue a double height, to ſee in them the more perfection, alſo a double height, to make them ſhow the better: for otherwiſe they would ſeeme too little for the reaſon aboueſaid againſt our intention.

The 72. Figure.

THe Profile ſhalbe made as in the 12 Plate of the former figure 70, by drawing a privie line infinite, and takeing upon it all the dimenſions, as firſt the bredth of the ramparts, the parapets, the falſebrayes, its parapet, the bredth of the moate, the covert way, and the other parts of the ſaid profile; and ſeing wee haue here ordained Ravelins, wee will make this profile from the midſt of the rampart, paſſing alſo through

graduate, the other angle CAD of 20 degrees (of 20, becauſe that the angle flanking interiour, which is alwayes equall to it maketh here 20 degrees) by meanes of the line indefinite AC, upon which ye make the length of the face 24 rod, as from A to C, from which point C, the perpendicular CD being drawne upon the line A,B, ſhalbe placed from D, the length of the curtaine, which is here 32 rod as from D to E, finally the diſtance AD from E to B, and the perpendicular EF the diſtance of CD as from E to F, drawing the line FB, ye haue the other face, ſo that all the parts of the reaſon giuen are deſcribed; and for to finde the curtaine, ye muſt make firſt the angles GAB, & GBA of 60 degr. ſeing the whole angle of the *Polygone* maketh 120 degr. by the lines AG, GB, which cutting through on an other at G, is the center of the *Polygone*, and ſeing the gorge, when as ye would make caſemates in them or in a bulwarke where Cats or mounts are raiſed, they had neede of a larger extent, then otherwiſe; we ſuppoſe that it were requiſite, to make Caſemates in them, to that end we make the angle HKA, which otherwiſe might be but 40 degrees onely of 35, according to which the gorge in the flanke wilbe almoſt as 4 to 3, or ſomewhat more by reaſon of the line H, K, cutting the line *Diagonall* AG at H, from which point H the line HN being drawne, parallell to AB, ye ſhall haue the *Polygone* interiour, upon which the lines CL, and FM, being drawne in length the lines DC to L, and EF to M; in ſo doing all the eſſentiall parts of the ſaid Fortreſſe, wilbe deſcribed; Now to continew the ſame draught or platforme in every place ye ſhall make from the center G a privie circle from the diſtance GB, and ſhalbe ſett upon the privie circumference the diſtance AB, which being the 6 part of the ſaid figure *Hexagonall*, the ſaid circumference will contayne juſtly ſtill fiue parts, which finally will come to end at A. In the like manner is the privie circle made out of the ſame center G, and from the diſtance G,N, upon the circumference thereof ſhalbe ſet the line of the *Polygone* interiour HN, afterward ye muſt onely coppie out the reſt. Moreouer, the parapet wilbe 20 foote, which ſhalbe made in the inſide of ACL. MFB, and as the way of the rounds, or the falſebray, is on the outſide of the body of the Fortreſſe, we will make parallells towards the moate of 20 foote broad, & then 20 foote more for the parapet thereof, on the outſide of the parapet, before ye come to the moate, is made an edge, or a toe of 6 or 8 foote, to keepe the ſaid parapet from falling into the moate, which is made of 140, or 150 foote or thereabouts, as neceſſitie, and the bottome requires; for it muſt be fitted according to this conſideration, becauſe the ground lying lowe, it will not beare much digging before ye come to water, and therefore in this place one is forced to make the moate to gett earth enough for the rampart, but when the ground lies high, then ye may digg very deepe before ye come to the water, & ſo by this meanes ye may haue aſmuch earth, as poſſibly ye can well uſe, & ſeing without it cannot be but hurtfull, it wilbe better not to make the moate ſo broad, that ye may receiue noe hindrance or hurt by the ſtore of Earth that it affordeth; which may be caſt upon the outſide: For to beleeue that the ramparts being raiſed higher then the dimenſion giuen in the former figure to wit of 14; or at leaſt 15 foote, that they were better as ſome haue mainteyned, yet experience hath ſhowne many times the contrarie, for an ennemie hauing once approched to the brinke of the moate, the bredth of the parapet hinders one from makeing any defence upon it, which notwithſtanding is moſt neceſſarie: becauſe the neerer an ennemie comes with his approches towards us, we ought the more to defend our ſelues, and this being committed by our default, it is too manifeſt that one ought to take heede of it, and to remedie this errour by the former way: namely in makeing the rampart of the heigth abouesaid. Some are of the opinion by a ſimple cōmaund that one ought to heigthen the ramparts aboue the ſaid 14 or 15 foote,

and

and not the Bulwarks, for which they haue ſome reaſon; for indeede the Bulwarkes make the greateſt defence, and when an ennemy is become maſter of the ſaid bulwarke, there were a meanes to cõmaund the ſaid bulwarke more abſolutely, ſo that an ennemy could not hinder the uſe of them, if he raiſed not his works aboue the ſaid rampart, to hinder the defences of the beſieged, which they might make with the ſaid ramparts ſo raiſed by a ſimple commaund, which in ſome manner might hinder the intents & approches of the beſiegers, the more eaſie would the entrenchements be made, and ſeing the more the bulwarks are raiſed, the more one ought to uſe diligence about the entrenchment; hence would follow this difficulty, that the comming to the rampart or the bulwarke, would not be ſo eaſie, as otherwiſe, neither could one make any great defence from ſuch ramparts by reaſon of their too much heigth, in ſuch ſort that one bulwarke ought to defend an other, & in ſuch a caſe the ſecond flanke would be of noe uſe after an ennemy is entred into the moate, at which time it is then moſt needfull to giue the greateſt reſiſtance that may be, ſeing that when they are gotten ouer the moate, and taken in the foot of the bulwarke, then the courage of the beſiegers begins to encreaſe, & the beſieged to faile them, for it is too apparant, that many times reſiſtance failes in ſuch and the like accidents.

Betweene two bulwarkes are commonly made ravelins or halfe moones, which are Quadrangular figures, euery face containing 12, 15, or ſometimes 20 rod, which beginn at the brinke of the moate: ſo that its angle interiour, or the tenaille O, lies juſt upon the brinke and angle of the moate, the reaſon why their faces P, Q, and Q, R, are made of a greater diſtance, is that the deffence may be the better: for otherwiſe their could be noe defence made but from one part of the face of the bulwarke, which otherwiſe would not be ſufficient to hinder the aſſaults of an ennemie, which ravelins or looſe peeces lie ſo open and are raiſed aboue the plaine field ſome foure foote, that one may the eaſier diſcouer the ſaid field, and ſo alſo to prevent the inconveniences which might happen, when one would giue fire from them upon the beſiegers, (if the ſaid ravelin had not bene raiſed) which would haue annoyed thoſe which were under the covert way. Upon the ſaid Ravelin being ſo raiſed, is made a parapet of 20 foote broad, and 6 foote high, which wilbe able to reſiſt Canon, the moate whereof ought to be made 50, or 60 foote, and as deepe, as poſſibly may be about the ſaid moate, ye muſt make alſo a covert way of ſome 20 foote broade, as hath bene noted before; Afterward ye muſt make a parapet of 50 foote broade & ſix foote high, ending at the end of the 50 foote towards the plaine field; as the profile doth ſhow in the 72 figure, and to the intent ye may the better underſtand my meaning, we haue made the ſaid *Hexagone* in perſpectiue, with the falſebrayes, Ravelins, covert wayes, and their parapets apart, as appeareth by the ſecond 71 figure, but ye muſt note, that the ſaid Ravelins muſt be in reſpect of Ramparts, which haue a double height, to ſee in them the more perfection, alſo a double height, to make them ſhow the better: for otherwiſe they would ſeeme too little for the reaſon aboueſaid againſt our intention.

The 72. Figure.

THe Profile ſhalbe made as in the 12 Plate of the former figure 70, by drawing a privie line infinite, and takeing upon it all the dimenſions, as firſt the bredth of the ramparts, the parapets, the falſebrayes, its parapet, the bredth of the moate, the covert way, and the other parts of the ſaid profile; and ſeing wee haue here ordained Ravelins, wee will make this profile from the midſt of the rampart, paſſing alſo through

through the midſt of the Raveline, that ye may the better underſtand our meaning. According to which ye ſhall take the bredth of the Rampart 68 foote from A to C, from C to D 20 foote, from D to E 20 foote, and from E to F 6 foote, the bredth of the moate ſhalbe 150 foote, as from F to G, which ought to be broader, but ſeing the diſtance falls out too litle, it ſhalbe made but of 150 foote, the Raveline ought to haue in this place 180 foote, but ſeing the ground faile us, wee haue made the dimenſion thereof 180 foote, but this hindrance would not permit us, to make it of that competent greatneſſe as it ought, which I ſpeake to giue noe ſtop to the Reader, which Ravelin is raiſed 4 foote aboue the plaine field from 6 to T, upon which a parapet is made, whereof the baſis ſhalbe 20 foote broad, and 6 foote high, to wit its bredth from Q to R, and the height from Q to S, the footebankes are made of the ſame bredth & heigth, & therefore I will make here no mention of them, neither of the taluds or ſloopings of Ramparts, Parapets, & moates, aſwell the interiour, as the exteriour parts are made according to the nature of the ſoile; for by how much the ground is leane & ſandie, by ſo much ye ought to giue it the talud, & by that meanes ye ſhall hinder the falling downe of the workes, for which reaſon often times ye muſt giue on the exteriour ſide, being a ſandie ground, as much talude as heigth, and if the ſaid Ravelin be alſo raiſed 4 foote aboue the plaine field, me thinks it will not be amiſſe, to raiſe the rampart thereof, which is 15 foote, ſome 6 foote higher to commaund the better the ſaid Raueline, & leaue the Bulwarks of the height of 15 foote, that all ineonveniences may be prevented: on the outſide of the Raveline is made the edge HI of 6 foote, and a moate of 50 foote, then the covert way 20 foote, & the parapet LN 60 foote, with a footebanke of the ordinary bredth of 3 foote in that manner, as the 72 figure demonſtrateth.

The deſcription of the plote of a Fortreſſe Heptagonall.

The 14. *Plate, and* 73. *Figure.*

LEt there be giuen to be fortified a *Heptagone*, whereof the ſide of the *Polygone* exteriour maketh 63 rod, and the angle flanked 80 degrees. To doe this, ye ſhall firſt divide the ſaid ſide AB into 7 equall parts, as ye ſee by the points 1. 2. 3. 4. 5. 6. 7. and from the points of the 5 and 2 parts the perpendiculars D, N, and E, O ſhalbe drawne being equall to A, D, and E, B, to wit, either of them 2 ſeuenth parts of the line A, B, then ye ſhall draw from the extremities, or the utmoſt parts of theſe perpendiculars, the privie line infinite H, I. which ſhalbe the ſide of the *Polygone* interiour, and by conſequence N, O the curtaine. The angles C, A, B, and C, B, A, ſhalbe made by the helpe of a graduate-inſtrument, as our compaſſe is, or an other; either of 64½ degrees; in ſuch ſort that the interſection of the lines A, C. C, B, which is C, ſhalbe the center of the ſaid Fortreſſe *Heptagonall*. Afterward I, B, 8, of the 40 degr. which is the halfe of the angle flanked, that ye may haue the whole angle of 80 degr. according to the *Hypotheſes*, and where the ſaid lines cutt the ſaid perpendiculars D, N, and E, O, in the points 2. & 8, ye ſhall haue the faces A 2. & B 8, the flanks N. 2. & O. 8, and alſo the gorges H, N. & O, I, the Parapets, Ramparts, Falſebrayes & for the other parts of this Fortreſſe, ye ſhall doe the like as hath ben taught in the former figure *Hexagonall*, the faces in this preſent Raveline ſhalbe made of 15 rod, the moate of 10 rod, and the moate to the Ravelin of 15 foote, then about it ſhalbe made a covert way of 20 foote, & a parapet of 60 foote broad deſcending (as we haue ſaid before) ſloopingly. According to this forme the flanke wilbe then made of a reaſonable greatneſſe, but the gorge ſo much the leſſer, which may be made ſo, ſeing ye intend

ye intend not to make any flankes in the Casemates, but in case ye would, ye must then make the flanke the lesser, and consequently the gorge the greater, to the end ye may haue space enough for to make within them the said Casemates. The like is to be understood when ye meane to make a Catt upon the Bulwarke, for the gorge being so litle (besides other inconveniences) it is impossible to make there such a bodie, in reserving sufficient space for the flanks, which me thinks in such places, that haue such narrow gorges, it were better to make the said Cats upon the Curtaine, yet so that they be noe hindrance to the Rounds going along the Ramparts, for which reason they ought to be made more inward, and so that they may lie as neere the rampart as possibly may be, the better to discouver, and commaund the fields about them.

The 74. 75. Figures.

THe figure 74 is the profile of the Rampart, Falsebray, its Parapet, moate, covert way, and its parapet, whereof the length, bredth, heigth and depth are marked out in the said figure 74, which is a section of the Bulwarck, as the figure 75, the section of the midst of the Rampart, and because all the profile cannot commodiously be drawne out, we haue represented but a part of the moate, the forme of the Raveline, its heigth, and the forme of its parapet, the bredth and the depth of its side, with their taluds or sloopings, the covert way with its parapet & footebanke, as ye may exactly note by the figures hereunto annexed.

The 2. of the 14. Plate.

AND for the better facilitating of that which we haue spoken of this present figure 73. we haue added hereto the platforme of the Fortresse of *Coverden in Frizland*, whereby ye may the better understand our intention, being accounted the master peece, and the most regular, and royall Fort in the Low-Countries, hauing a Falsebraye, Rauelins, or half moones, covert wayes, with which wee will put an end to the description of our regular Fortresses.

A succint description of some other works in the said Heptagone, which are of an other manner of makeing then the former.

The 15. Plate, & 76. Figure.

LEt the side of the *Polygone* interiour be B, C, upon which ye would haue a part of a Fortresse *Heptagonall* made, whereof the face to the curtaine is as 3 to 4. and the gorge to the flanke as 13 to 9. To doe this, ye must doe as we haue taught yow in the 11. *Plate, or in the* 9. *Plate, and Figure* 3. 50, where ye shall finde the proportion requisite: on the outside of the same face, shalbe made the parallells each of 20 foote, aswell for the parapet, as for the falsebray, the like is to be done in the flanks, and curtaines, and on the inside a parallell of 20 foote, with an other parallell of 72 foote for the bredth of the Rampart in the basis, in the same manner as this 76 figure sheweth, on the outside ye shall make a parallell of 10 rod for the bredth of the moate, and upon the brinke of it to the *tenaille*, ye shall lay out the Ravelins, as we haue said in the former figure 73, in the angles of the Bulwarks ye shall make also Ravelins, such as ye see here marked with I, K, L, M, which shalbe defended by the Ravelins E, F, G, H, & the better to defend the said ravelins, which are in the angles of the Bulwarks, ye

ſhall make the other works N, O, P, & Q, which are called Horne-works, which are made in ſuch a manner, that the moates of theſe Horneworks comes to anſwere to the Falſebray, which is in the flanks of the Bulwarks: ſo that their bredth S, T, maketh about 32 rod, of which diſtance the two demy-Bulwarks V, X, are made (whereof the face, and the curtaine are of a like greatneſſe) according to the rule preſcribed in the 10. Plate, the flanks wilbe found, makeing from the angle of the ſhoulder, two lines perpendicular upon the curtaine, which is directly oppoſite to it. euen as the figures 77, 78 demonſtrate. The utmoſt angles of the ſaid Horneworks ought not to be further from the curtaine of the Fortreſſe, then a Muſket can carry point-blanke, which is 60 rod or there abouts, and if the Rauelins EF, GH, are not made in the tenailles, then ye may cut the ſaid Hornworke, as is here marked out in the 78 figure: the bredth of the moate ſhalbe 24 or 25 foote: The Rampart here is noe otherwiſe then the parapet of the ſame bredth.

The depth of the moate may be made 6 foote in caſe the ground lies low; but otherwiſe the deeper it is made it wilbe ſo much the better, the bredth will not hinder it, though it were made but 36 foote; for according to the ſame bredth & depth ye may enlarge the Rampart, aſwell in height as in bredth, upon which afterward ye may make a parapet as great as it can well beare: but when haſte requireth, I would make noe Rampart, but onely a Parapet of 24 foote thick, as wee haue made here being 6 foote high, and a footbanke of 3 or 4 foote.

The figure 79 marketh out a *Profile*, which is a ſection or cutt drawne through the midſt of a curtaine paſſing through the midſt of the Ravelines G, and traverſing through the Horneworke P, and the Rampart and the moate. The true dimenſions thereof are clearely expreſſed in the ſaid *Profile*, by the helpe of the ſcale; joyned to it: as alſo by the meanes of the *Alphabeticall* letters, ſhewing the feete to be 12 ynches, whereof the length is ſett down in the 25 Plate of our Geometrie.

The benefit of ſuch workes are well knowne, when they are made in places of advantage for deffence, or where noe men, victualls, and amunition of warre are wanting, as alſo where the ground is of a reaſonable largeneſſe, to wit at the leaſt 32 rod, that the faces of the ſaid horneworkes may be about 12 rod, which is the leaſt length that one can giue to ſuch workes, againſt the attempt, which may be giuen by an Army: & as a great aſſault, cannot be reſiſted with a few men, but up a ſmall roome: ſo is it manifeſt that the greatneſſe & largeneſſe of ſuch a place, muſt be anſwerable. Therefore in my opinion, it is a thing repugnāt to the rule of Fortification, to make ſuch Horneworkes in the angles of Bulwarkes, where they are ſo ſtraightned. For Demy-bulwarkes cannot (by reaſon of their ſmallneſſe) be vvell mainteyned and defended, and on the other ſide, their tvvo vvings cannot be defended from the maine Fortreſſe, but vvith great diſadvantage, as vvee intend to diſcuſſe: thereof more at large hereafter in the plateforme of *Gulick*.

How Citadels, or Caſtles may be joyned to Townes, or Townes to Caſtles.

The 16. Plate, and the 81. 82. Figures.

FOr to build a Caſtle (or a *Citadell*) to a Towne, either to help to defend it the better, or to curbe it: ye muſt finde out firſt the moſt advantagious place: in caſe there be a river, then ye ſhall build your Caſtle upon the ſide of it, where it may beſt commaund,

commaund, with all the advantage that possibly may be, also takeing heede that it be built in such a place, that the Castle may receiue noe disadvantage thereby, but that the Rampart of the Towne where the letters A, G are, be the weakest part; to the end that by this meanes, ye may frustrate the desire of the inhabitans of the said towne, from opposing themselues against the said Castle: but if ye feare noe such inconvenience, ye may make the places A, G, as strong as the other: saving that the Ramparts in the said angles be noe thicker in the angles A, G (which are angles of imperfect Bulwarkes) then in other places, and not massiue or full of earth, as the Bulwarkes B, & C, D, are. Let there be a towne then contayning 8 angles, whereof 7 of them are marked out with these Alphabeticall letters A, B, C, D, E, F, & G, and that you are desirous to make a *Pentagonall* Citadell. For the doing whereof ye must first make a mapp of the said towne *Octogonall*: in case it be not made, according to the methode giuen heretofore in our Geometrie, which is here marked out by these letters A, B, C, D, E, F, & G, with the Falsebrays, Parapets, Moates, Covert way, & its Parapet. Then upon a paper of the same scale, whereof the mapp of the said towne is made, being traced out in a *Pentagone* with all the outworkes, such as the figure marked H, I, K, L, M, demonstrats, according to the method giuen yow before in the 10 and 11 Plates, then the same figure *Pentagonall* must be cutt perfectly, and so fitted to the towne, remouing it so longe till yow haue at length found out the most advantagious place to make there your Castle *Pentagone*, takeing heede that the *tenailles* N and O, fall out right, to answere the curtaines P, O, and Q, N, to the end that the entrance into the towne may be the more commodious, & that the towne in the places N, R, S, T, O, be not discouered without, whereof one ought to haue a singular care: for there where the said angles of the tenaille, be not well joyned to the Ramparts, those places will alwayes be badly defended in the said joynings, as ye may obserue in the Castle of *Gulick*, which platforme followes next. It is true; that when ye make these angles in the curtaines, that the parts N, R, S, T, O, take up a great deale of the towne, which may be prevented in setting the Castle more outward, and makeing the said curtaines meete neerer the faces of the Bulwarks of the Castle. But the side of the towne N, R, S, T, O, will in noe wise be guarded, as the Platforme of the Castle of *Gulick* sheweth: so that necessity will require, for the preventing of such an inconveniencie, to make some Ravelins, or some other works without the said place, as the commodiousnesse of the ground may afforde, which would make mee resolue rather to approue of the forme of the 80 figure, then of the other, were it not for some cause more urgent, then is here alledged, which reason would moue mee to change my opinion.

If the towne or Cittie A, B, C, D, E, F, G, were greater, then were it vnnecessary to take so much care for the place, which the Castle taketh up: for then ye might make the curtaines P, O, & Q, N, longer, to wit some 50 rod, that the flanks V, X, and Y, Z, might not come so neere the Bulwarks E, M: from whence one may easely discouer the Falsebray of the Castle, for the preventing of which inconvenience, it wilbe good to raise the Bulwarkes of the Castle, which looks into the towne, somewhat higher aboue the Ramparts thereof, but the towne being of a small circuit (as wee haue said) one shalbe constrained to use for it the same figures as are demonstrated by the figures 80. & 81.

If one would built a towne to a Castle, first ye must obserue diligently the site of the place, and if it may be made regular, to take care, how many Inhabitants this place will containe, the nature and quality of them, and whether the towne may in processe of time be enlarged: which ye shalbe able to judge, when ye see the countrie that lies about it, what wayes, avenues and passages there are to come to it, as also to

conſider the goodneſſe of the aire, and of the ſoile of all which things (as *Vitruvius* ſaith) one ought to haue a moſt ſpeciall care. According to all which one ought to gouerne themſelues: for to encloſſe a great peece of ground, where there is none, or little appearance of Inhabitants, this were rather to ruinate, then to edifie, to which takeing heede then, ye muſt reſolue of the Circuit, or Capacity, which ye would giue to the ſaid towne, and ſuppoſe ye would make the forme thereof *Octogonall*, and regular: ye muſt trace out then an *Octogonall* Fortreſſe regular, according to the former method, with covert wayes, and what ye require more upon the ſame ſcale, as you made your Caſtle *Pentagonall*, then ye muſt cutt the ſaid forme *Octogonall*, and joyne it to the ſaid Caſtle, removing it ſo long, till yow haue found out & choſen out (with all circumſpection requiſite) the moſt conveniente ſt place, and ſtaying there ye may trace out the ſaid towne, as the figures 80 and 81 demonſtrate, joyned to the Caſtle. But as we haue ſaid, it will looſe much of its capacity, becauſe the curtaines of the towne will come to meete with the angles of the tenailles of the Caſtle in the points marked O, and N.

The 17. *Plate, and the* 82. 83. *Figure.*

IF ye will not tye your ſelfe ſo preciſely to this forme *Octogonall*, ye may make the towne much better by the meanes which wee will now ſpeake of Let firſt be drawne the lines D,D, and A,A. &c. right perpendiculars upon the midſt of the curtaines N,M, and K,Y, of ſome 60 rod, or there abouts, then let there be made the perpendicular line infinite in the midſt, and upon the curtaine D,E; in which ye haue the center of the circle, which makes the circle of all the figure, and ſuppoſe ye deſire to make a forme regular of nine Bulwarks, whereof the angles flanked, are diſtant one from an other 80 rod, from the utmoſt end Q, ſhalbe made an arch, in ſuch ſort, that within the circuit thereof the diſtance N, P, is contained 9 times, which ſhall make the point of the center C,C. then upon the circumference of the ſaid arch the ſaid 9 points, being marked as they are noted here by the letters Q, R, S, T, V, X, Y, Z, &c ye ſhall make the angles interiour flanking, according to their forme, that ye may haue the angle flanked right, & that ye may the better make the angle flanking, or the tenaille pointed and ſmall, which is accounted the beſt, as that ſkilfull, and diligent man *M. Iohn Errard of Barleduke*, Ingenier to the King of France hath obſerued well, and to know how much the ſaid angle flanking will make, ye muſt ſubſtract the halfe of the angle from the Bulwarke, or flanked from the halfe of the angle of the *Polygone*, the reſt ſhalbe the angle flanking interiour. But if the angle of the *Polygone* be leſſer then 150 degrees, which is the angle of a *Dodecagone*, ye ſhall then governe your ſelfe according to the table giuen before, takeing heede that the angle of the *Polygone* agreeth moſt with the angle to be fortified, and in its columne is found the angle flanking interiour, neceſſary to the ſaid angle, by which ye may come to the angle of the *tenaille*, & ſeing in this exemple wee haue ſet downe the diſtãce frõ angle to angle, as wel of the *Pentag.* as of the towne 80 rod, wee wil ſet downe upon the lines, which make the *tenailles* 2 equall parts, & from the ſaid 2 parts in the line which formeth the angle flanking, a parallell line being drawne to that of 80 rod, & placed upõ the 3 equall parts, a privie line infinite, muſt be drawne through the ſaid 3 point, & through the angle, and where the ſame comes to cutt the other ſide of the *tenaille* in the point O, ye ſhall haue the ſhoulder, through which the line A,B, being drawne, makeing the angle forming the flanke 40 degrees, ye ſhall haue the center of the Bulwarks juſtas wee haue taught heretofore in the 10 & 11 plates. If the Caſtle had bin made with foure angles, the conſtruction would haue ben the ſame,

ſame,and if the lines D,D,Q,and A,A,&c. had bene ſomewhat more then 60 rod, the forme would haue bene better, for though we haue made the lines of defence, to be 60 rod in the former Fortreſſes, there is an other conſideration in this preſent building; in regard the Bulwarkes Q, &c. advance themſelues towards the angles Q,&c. from whence the ſaid curtaines Q,E,E. & B,B &c. maye be ſufficiently defended, when they doe not exceede aboue 70 rod, the moates, covert wayes, falſebrayes and other workes, muſt be made in that forme as we haue ſett them downe before in the 16. plate.

How to deſcribe the order which is obſerued in makeing of a platforme,and of ſome other appendances.

THe draught being made upon a paper, ere ye make a platforme of it, ye ought firſt to ouercaſt,aſwell the lines, as the body of the Fortreſſe, in that manner as we haue ſhowne yow before in our *Geometrie*, that ye may know pertinently all the particular dimenſions, & ſo committ noe errour, in makeing a plateforme thereof: Before ye lett it out,according to our Method giuen in the concluſiō of the practize of *Geometrie*, which being done before the Inginier begins the worke, he ſhall declare the particular conditions, which he would haue obſerued in the makeing and finiſhing of this worke,as the time when they are to beginn,how long it wilbe before it be finiſhed,how many men he muſt ordinarily haue to worke, what inſtruments they muſt uſe for the driving in of piles,and the laying of the foundation,how many foote,and what edge they are to giue to the wall,or the parapet of the falſebray, the thickneſſe of the parapet,and how broad the falſebray ought to be, how much the talud (or ſlooping) on the inſide and on the outſide muſt be, and that according to the goodneſſe or weakneſſe of the matter upon which one builds, how many bundles of bruſh in a ſandie Earth he is to lay in the parapet of the falſebray, and in the Rampart,the height,the Talud or ſlooping,both on the inſide,& on the outſide, the bredth and depth of the moate, & its ſlooping, and generally and ſpecially all things touching the makeing of ſuch a Caſtle,whereof he hath made his platforme. And ſome dayes before they come to the place, or that the forme be drawne out, they ſhall ſett up billets in the next adjoyning townes to giue notice to the Worke maſters,that upon ſuch and ſuch a day,one is reſolued to hire and let out ſuch&ſuch works, to him that will take them on upon the leaſt price: and before the day prefixed the ſaid Inginier ſhall come thither himſelf with ſome one of the Deputies, or ſome other that hath the managing of that worke, to draw a draught of the ſaid Fortreſſe, and to prepare all things neceſſarie againſt that day aſſigned. Then tho day being come,all the Worke-maſters & Undertakers ſhall come together, either upon the place where the worke is to be made, or elſe in ſome other place where the conditions and couenants are read, according as they will haue the worke haſtned: this done,they ſhall demaund,who will take it on for the leaſt money, then one of the Workemaſters will ſay for ſo much, an other for ſo much leſſer, which is done till noe man will take it on at a leſſer rate, then underneath they ſigne unto the articles of the conditions,that I N, N, haue undertaken the worke upon ſuch and ſuch conditions, for the ſumme of ſo much money: ſometimes ye ſhall haue two or three Undertakers joyne together and undertake the whole worke, all of them ſigning to the articles, as alſo the Commiſſioners, and Inginier muſt doe on their part: then they beginn the worke, and commonly the Undertakers are bound by the ſaid articles and Contracts,to deliuer all the materialls neceſſarie for the ſaid worke, which they receiue from the Maſter of the Magazin there or elſe, where

giving him a note under their hands for the reſtitution of them back againe, when the worke is finiſhed, and to make good whatſoeuer they either breake or looſe.

Then the Workemaſter placeth his men in order, as he knowes the quality of the worke requireth beſt, ſome to digg, and caſt up the Earth, others to fill Karrs, and Wheele-barrowes, others to levell the ground which is pricked out; for in the beginning it wilbe neceſſary to carry the Earth away, with a Horſe and a Karre, which is caſt up on the outſide of the moate upon the baſis of the Rampart, & not with Wheele-barrowes as they muſt doe at the laſt, when the worke growes high, and that ye are come to the depth of the moate, for then ye cannot ſo well uſe Horſe and Karrs; by reaſon of the difficulties knowne to all men, namely, that the treading of the horſes and the Karrs ſpoyle the groundworke, and cannot be laid ſo well, as when men brings the Earth up in Wheele-barrowes upõ away aſcending with plancies, as hath bene found by experience often times by the undertakers of ſuch workes.

Of the Foundations.

2. *The* 17. *Plate.*

WHen the foundation is bad, it wilbe your beſt courſe to driue in piles, along the foote of the Rampart, juſt where the ſaid Rampart beginneth, ſome piles 25, or 30 foote, or elſe yong Alders-trees, about foure or fiue yeares growth along the worke about 18 or 20 foote long, cloſſe one to an other, and the cloſſer the better, and though this be a great charge, and a long worke; yet this is the beſt foundation ye can chooſe: But as we haue ſaid oftentimes, ſeing it hapneth that one cannot ſtay ſo long, ye muſt then take bundles of bruſh, and binde them up in fagots, & lay them croſſewiſe, driving them into the Earth with ſtakes to faſten them together, that they may lie firme, and if ye lay the foundation in a ditch or a quagmire, ye muſt make uſe of ſuch fagots bound and tyed up together with cords, & if it be in a river, then ye muſt binde brickbats, or ſtones betweene two bundles, to make them ſinke to the botome: ye may make them as long, or as ſhort as ye pleaſe, and ſo neceſſity requires, till ye haue filled up the water with theſe ſinkers, upon which yow muſt lay your foundation, then ye muſt alſo driue in ſome piles about 18 or 20 foote longe, (according to the depth) to make them lie the more firme and ſolid together. Now theſe bundles are made in the forme of *Saucidges*, as here followeth.

Firſt, ye driue into the ground ſtakes of the heigth & bredth as ye deſire to make theſe *Saucidges*, either great or ſmall, the one a foote high, the other a foote and a halfe, and ſometimes two foote, then ye lay betweene theſe ſtakes bulruſhes, boughs or ſmall bundles of bruſh bound faſt together, and in the midſt of them ye muſt lay brick-bats, when ye ſinke them in a river, but of Earth if ye will lay them as a foundation in a moate all along the ſaid worke, then ye binde the ſaid bundles with ſtones, or Earth in them, faſtning them with withs in the ſame manner, as ye binde up a fagot, or a bavin, and in this forme are your *Saucidges*, or ſinkers made, which being done, the letters A are bound one to another, as ſtrong as poſſible may be, as ye may perceiue by the letter B in the 2. 17. Plate.

Then ye ſinke theſe downe to the bottome, that ye may afterward build your Fortreſſe upon them, according to the former platforme, whereof a Plate is made before, which groundworks among the Ingeniers of the united Provinces are much uſed, becauſe theſe parts are maritimate, mooriſh, and ſubject to bad foundations, ſo that in ſome places the foundations coſt more then the reſt of the building it ſelf,

yea

yea in diuerſe places of theſe Countries, the Inhabitants are driuen to keepe their grounds from the violence of the Sea and Rivers, by ſuch and ſuch like meanes and remedies, to their great and unſpeakeable charges, for one would haue thought it had ben impoſſible for them ſo many yeares to doe it, ſince the times that theſe Provinces were united, had not the ſuperintendants, & Dikegraues uſed great care and diligence in continuing the ſame preſervation for the good of the inhabitants, and common weale, whereof wee will ſpeake more at large hereafter.

When the worke is raiſed aboue thé water, and that the Earth in the moate diminiſheth, the Worck-maſter ſhall then beginn to lay his edge, or border upon the line drawne out for the Rampart. Now the line being drawne out upon the ground, as ye ſee in the line C. by the 2. of the 17. Plate, being fiue or ſix ynches broad, and as deepe, which is done by the Ingenier himſelf to take away all excuſe from the Work-maſters, that he may likewiſe carrie a right line, aſwell on the inſide as on the outſide of the Rampart, as alſo for the moate, and the other parts of the ſaid Fortreſſe, repreſented in the plat-forme: Beſides if the condition of the undertaker containes, that the outſide of the Rampart muſt be raiſed with ſodds, which are ordinarily 4 or 5 ynches ſquare, and 14 or 15 ynches long diminiſhing towards the inſide, as ye may ſee here by the figure D, to the end that betweene the ſaid rowes of ſodds, one may lay a litle earth to ſettle them the better together to the bodie of the Rampart. Moreouer, they are ſo laid together that the rowes aboue muſt lie euen in the midſt of the joynture of the rowes beneath, makeing them ſettle together according as the condition beares, and as the articles are which the undertaker hath ſigned unto. Now for his better eaſe, he muſt make uſe of a triangular Inſtrument, ſuch a one as the letter F demonſtrats, being the ſide A,B, about 2, or 3 foote more or leſſe, according to the quality of the worke, and the reſt ſo conſequently: For as ye deſire to haue the Talud, either great or little, ſo ye muſt enlarge the line A,G, or leſſen it: If it be needefull to lay bundles of bruſh to ſtrengthen your works of the Fortreſſe, ye muſt lay them ſo that the ends touch the former ſodds, to wit the one row half a foote aboue the other, and betweene each of them halfe a foote of Earth, continuing the worke ſo untill it be finiſhed: upon the top of the Earth of the Rampart, ye ſhall raiſe the parapet with ſuch a Talud and bredth, as the conditions imports, in the ſame manner as before, raiſing it with ſodds, as we haue ſaid. If ye make your Fortreſſe in a fatt and a clayie ſoile, then ye may (in ſtead of ſodds) make a cruſte of 3, or 4 foote, or more, ſtamping it well with a ſtamper made to that end, and of ſuch an inclination as your agreement beares, in which cruſt ye may ſett a certaine kinde of graſſe, called in Flemiſh *Queeckcruyt*, in Latin *Gramen*, & in Engliſh *Meddouv graſſe*, which roote is of ſuch a nature, that it will ſpread itſelfe ouer the whole Rampart, and binde the Earth faſt together: ſo that it will make the ſaid cruſt of a long durance, and almoſt perpetuall: on the outſide of the ſaid bruſt, ye may ſowe Oats or Hay-ſeed: they uſe alſo to ſett upon the Bulwarke, roots of ſeuenleaued-graſſe, which is likewiſe very good: but the leaues doe not ſpread themſelues ouer the exteriour ſuperficies, or this cruſt, as the aboueſaid graſſe doth: for this reaſon ſome yeares ſince his Excellencie hath found it good, to repaire all the Fortifications of ſuch a cruſt without ſodds; becauſe experience hath taught us, that the ſaid ſodds bindes not the reſt of the Earth, ſo well as the ſaid cruſt doth, which being moiſt by that meanes joyneth ſo much the better the reſt of the wall or Rampart together, which is of very great uſe, and is quickly done.

The

The talud of the Rampart is made ſomewhat greater, that one may ſtand an end the better upon it, as ye may ſee by the profiles here before, aſwell of Ramparts as Falſebrayes. This being done, ye muſt make the parapet of the covert-way of earth digged out of the moate, whereof good ſtore was layd on the outſide of the moate, to that purpoſe: and the ſaid undertaker ought to that end make an exact calculation of the quantity of Earth, which is neceſſary for that uſe. But ſeing oftentimes the undertakers are not ſkillfull in eaſting up ſuch accounts: It were good that the Ingenier himſelf ſhould make an exact calculation, not onely of this part, but alſo of the whole worke, which may be done in that manner, as wee haue ſhowne in our *Geometrie*, or elſe in this eaſie manner following.

The ſecond 17. Plate, and Letters G, H, R.

LEt the 12 part of the Fortreſſe be *Dodecangular* G, and AB the face 24 rod; the flanke AD 12, and the curtaine 36. and for the Rampart H. Let the talud interiour be 15 foote, and the heigth aſmuch, the talud exteriour 10 foote, the bredth upon the Rampart 50 foote, which makes that the ſuperficies of the *Profile* of the ſaid Rampart wilbe 933½. Moreouer, for the *Profile* of the parapet, which is K 99¼. the heigth EC 6 foote, HF, 4. AB for the footbanke a foote and a halfe; AC 3. BD 2. CG 20. HG 2½. the ſolidity of the Rampart & the parapet is required.

Of the Rampart.

THe *Icnographie* ſheweth, that CM 10 foote is the talud exteriour, and HN 15 foote the interiour, the angle B is right in the *Dodecagone*, and in the *Polygones* upon it, ye muſt remember once for all, that if the *Profile* on all ſides hold one & the ſame dimenſions, to wit in the faces, flanks, & curtaines, the angles BAD ſhalbe cutt by halues from the lines HB, EA, KD. Alſo the angle of the *Polygone* being 150, & the flanked right; the angle flanking interiour wilbe 30 degrees, as it is marked, and the ſhoulder 120 degrees, which makes that the triangles right-angles are as followes: thoſe which haue their angles pointed of 45 degrees, ſhalbe *Iſoſceles*, or like angles, BM, MC upon the baſis each of them 10 foote, the lines C 3. 3 G, each 50 foote, BX & XH, each 75 foote, GN, NH 15 foote, and the like in the triangles hauing their Hypotenouſes at KD. Moreouer in the triangle ORA, in the ſhoulder RO 10, OA 5, 7735, the line marked 5 A, 43, 30125, therefore takeing the lines BX, and 5 A from BA 24 rod, or 288 foote, there will remaine HF 169, 69875. Likewiſe AD 144 foote, PD, or RV, wilbe 138, 2265, and by adding to it FV. FR will come to 148, 2265, the line A 12 is equall to A 5. taken from AD, there will remaine 100, 69857 for T 8, to which add 8 I, 60, TI will come to 160, 69875, and LI, 169, 359, add to the ſaid TI, IZ, 15, ye ſhall haue EK 175, 69875.

The demy-curtaine 13 D, makes 216, then 9 F, 226, alſo 11 K 291, & 10 I, 276: ſo that if ye add CR 272, 2265, RF 148, 2265, and F 9. which is 226, ye ſhall haue 646, 453 for CFR 9. the circuit exteriour.

Ye ſhall finde alſo GL 193, 359, & LI, 169, 35904: & 10 I, 276. whereof the ſumme for GLI 10, wilbe 638, 718 the circuit interiour, which being added to the exteriour abouenamed, will amount to 1285, 171, its halfe is 642, 5855, which multiplyed by G 3, the diſtance of the parallells 50, will come to 32129, 275 for the ſuperficies, betweene the aboueſaid circuits, and then multiply by 15 the heigths, ye ſhall haue the ſolidity of the wall, without the taluds 481939, 125. CRF 9. 10. ILGC, which had bene too ſhort as here followeth.

The

The Authour hauing made this aboue with ſo many lines, if from the midſt of LR, he had drawne a perpendicular line upon the face, and cutt af from it 20, 2071 its double ſubſtracted from the ſumme of the aboueſaid perpendicular, and from BA, AD, D 13, which is 683, the remainder wilbe 642, 5856, which multiplyed by 15, it wilbe the ſame as aboue.

Of the Taluds or ſlooping vvalls or Ramparts.

THe *Taluds* without the *Pyramids*, which are in the angles, ſhalbe calculated thus, their *Profile* is a triangle, which multiplyed by the length, or elſe as *Demy-parallelipedes*, the *Baſis* multiplyed by the heigth, afterward the halfe taken, add to it then CR 272,2265, RV 138,2265, with D 13, which is 216, the ſumme 626, 453 multiplyed by MC, 10, the ſuperficiall baſis wilbe 6264,53; likewiſe HE 169,69875, EY 160,69875 & I 10, which is 276, makeing together 606,3975, which being multiplyed by IY 15, will make 9095, 9625 for the other ſuperficiall baſis, together with the former will make 15360,4925 (becauſe they are of a like heigth) by which heigth of 15 being multiplyed, then the halfe will come to 115203,69375 for the taluds, aſwell interiour, as exteriour beſides the *Pyramides*.

Of Pyramids, *and double* Pyramids *of the* Taluds.

THere are 3 *Pyramides* in the angles *convexe* B, A, K, and three double *Pyramids* in the angles *concave*, H, E, D, which I ſay becauſe *Marolois* making no diſtinction of them, taketh two things for one: As for example, the body upon VFXD is 1000 foot *cubicall*, and he reckons but 500, and ſo of the two others.

The *Superficies* of the triangle BMC, is 50 from ROAP, is the right-angle RO, OA 57,735, and YIZK 225, and then the double *ſuperficies* of GNH 225 (according to that as we haue ſaid before touching the Authours fault) ESLT its double *Superficies* is 259,8057, & the double *ſuperficies* VFXC, of 200, whereof the ſumme is 1071, 5425, which multiplyed by the *tierce* of the common heights, ye ſhall haue for the aboueſaid ſixe bodies 5087, 7125, (whereas *Marolois* hath but 3375,69375) to which if ye add, aſwell the Taluds 115203,69375, as the Rampart 481934,125, the ſumme wilbe 602230, 5312, for the ſoliditie of the Rampart, beſides the parapet.

Thoſe which will not take the paines to haue it done ſoe exactly, but are contented to come ſomewhat neere unto it, ſhall add unto it BAD 13, which is 648, with HEK 11, being 636, 396, and the halfe of the ſumme multiplyed by the *profile* of the Rampart 937½ ye ſhall haue 602060, which comes the neereſt unto 602230, found out aboue (being onely 170 too litle) for *Marolois* found out but 600518, with much adoe, hauing 1712 too litle.

Of a Parapet.

WE haue before ſett downe the dimenſions of a *Parapet* as ye may ſee by the letter K, newly cutt, with its Rampart H, in this plate, & ye muſt not thinke it ſtrange, that the Parapet is made upon a greater meaſure, then that of the Rampart, the reaſon is, becauſe there are noe more diſſections, or cutting of, and that wee haue not roome to make that which we would within the ſome Plate.

Now if ye desire to calculate the *Profile* as the Authour hath done, the whole as the brevitie of the Rampart showes aboue mentioned, its situation is termined on the outside by CRF 9. and on the inside by a parallell line, betweene the abouesaid & GLI 10. distant from the other 20 foote, and for the avoyding of the confusion which the plurality of lines might cause, we will take for the said paralell, the line GLI 10, and therefore 3 G, or 7 S, will make 20, or else the line LT; ye shall finde by the triangles, that TR wilbe 5,369. add hereunto C 3, which is 20, and the summe of CR knowne aboue, taken from 272,2265, there will remaine for GL 246,8675, then from RF 148,2265, substracting the length equall to TR, 5,359, there will remaine 142, 8675, afterward add thereunto 8 V, or its equall 20, ye shall haue 162,8675 for LI; also F 9, being 226, then I 10 wilbe 246; then the summe of CRF 9, (added to GLI 10) and the halfe taken, ye shall haue for the middle length of the parapett 651,094.

For the *superficies* of the *Profile* of the *Parapet* K, the triangle EIF 17½: and DOE 2¼, the *trapeze*, (or unequally side) IFGC 75; and BOCA 4½, the summe is 99¼, for the *Superficies* of the *Profile*, which multiplyed by the middle length aboue said, ye shall haue 64621, 0795 for the solidity of the parapet, which is much too much; for it ought to be as I haue calculated it with its dissections 63976, 9475, to which add 602230,5312 from the Rampart ye shall haue 666207,478, for the whole solidity of the Rampart and Parapet, whereof the double 1332414, 956, wilbe the twelfth part of the Circuit, which multiply by 12, ye shall haue the totall summe 15988979, 472, and diuided by 144, ye shall haue 111034, 68 plyntides, or as *Marolois* calls them Chevilles, peggs or pynnes, for the whole circuit of the *Dodecagone*.

Seing then there are 9252, 88 pinnes in the 12 part of this Fortresse *Dodecagonall*, the Ingenier may conjecture, for how much he may let out the same worke, which is about 16, 20, 25 or 30 pinnes, according to the situation of the place, the ground and other considerations, and after that the undertakers shall offer to make it according to the calculation, made thereof, they may take on the said worke upon condition, that they shall finish it in such a time, & with so many men as is specified in the contract, and soe at that instant they beginn the worke, & finish it according to their bargaines and conditions, as the greatnesse of the worke requires, and the time limited, for which also the undertaker is bound to haue as many worke men upon it, as shall be found needfull for the finishing of the said worke: & for the better assurance thereof, it is requisite to know how many pinnes a man may spit, and lay upon a wheele-barrow in a day: for those that are skilled therein, say that a man if he works his best, he may dig & lay up 4½ pinnes in a day, but ordinarily men suppose that one can doe three pinnes euery day, without takeing too much paines, according to which, one may easely make his calculation how many spadmen he must use to make up that worke in such a time prefixed, for men which shall doe nothing else, but spit and digg up the Earth & the others to carrie it away upon wheele-barrowes to the Rampart, for ye must haue as many men to carry up the Earth in the wheel-barrowes, as that the spiters may be continually kept in worke without any cessation or stay, to the intent the Work-master may finish his worke within the time limited.

Note.

WE say here, that a man may in case of necessity spit in a day 4½ pinnes, and commonly three in a day with leasure, but it is to be understood, this must be in a good and fast ground, which wilbe beare spiting without falling or breaking; but when the Earth is leane and sandie, it wilbe impossible for a man to doe so much, & so by consequence one cannot know any certaine rule.

The 1. Maxime.

ACcording to which plotts and calculations all other places aſwell regular as irregular may be fortified, and hold this for a maxime, that the place ſo fortified, as we haue taught aboue, wilbe better then the others.

The 2. Maxime.

THat the line of defence which comes from the angle of the flanke to the angle of the Bulwarke, called the line of *deffence fichant* ought not to be much longer then 60 rod, becauſe it is as farre as a Muſket can well carry, but if ye will defend the face with Canon, then it may be a 100, or 120 foote longe.

The 3. Maxime.

THat leſſer the angle of the *tenaille* is, it is ſo much the better, becauſe the faces looke more directly one upon another, therefore ye may ſee that in the plots of the *Dodecagone* aboue ſaid: ye muſt make the angle of the Bulwarke onely of 90 degrees, that the angle of the *tenaille* may be ſhutt the cloſſer.

The 4. Maxime.

BY how much the flanke and the gorge are greater and ſpacious, by ſo much they are the fitter for defence.

The 5. Maxime.

THe further the defence is made in the curtaine, it is the better, becauſe ye may bring the more men to giue fire upon it, for the defence of the faces. Therefore in the plots of the *Dodecagone* aboueſaid, ye muſt ſee that the angle of the Bulwarke be made of 90 degrees, to the end ye may giue fire the larger.

The 6. Maxime.

That the angle flanked ought to be noe leſſe then 60, and not aboue 90 degrees.

The 7. Maxime.

THat the angle of the *Polygone*, which ye intend to fortify, ought not to be leſſe then 90 degrees, but the greater it is, it wilbe ſo much the better.

The 8. Maxime.

THat in all Fortreſſes wee will make the face to be 24 rod, and the curtaine 36, according to which the lines of the *Polygones* exteriour will make about 60 rod, and the lines of the *Polygones* interiour 60 rod. In a *Heptagone* and the *Polygones* underneath, the *Polygones* exteriour wilbe more then 80 rod, and aboue leſſe then 80. The *Polygones* interiour which are beneath the ſaid *Heptagone*, are leſſe then 60 rod, and aboue more then 60, the one encreaſing, the other decreaſing, untill that the

angles of the *Polygones* come to be 180 degrees, and then ye haue the *Polygones* exteriour, and interiour equall, and each of them 70 rod, the line of defence fichant in the whole about 60 rod, & the angle forming the flanke of 40 degrees.

The 9 Maxime.

THat the angle flanking interiour ought to be noe leſſe then 15 degrees, but the greater the better they are.

The 10. Maxime.

THat the angle of the flanke be alwayes right, the angle of the ſhoulder muſt be at the leaſt 105 degrees, and the greater the better.

The 11. Maxime.

IF it be needfull to fortifie any *Polygone*, either regular or irregular, whereof the ſides are leſſe then is here ſpoken of, then ye muſt proportion out the gorges, flankes and faces, according to the forme of the angle, as ye ſhall ſe in a table following.

Herewith wee will put an end to our firſt part of Fortification, and will come now to the fortifying of places irregular.

FINIS.

N

le
ıd
or
it
ks
at
it
as
e-
le
n
i-
:e

ıe

TABLE OF THE FORTIFICATION IN

The first manner is.

When the angle flanked is 15. degrees more then the demy angle of the Poligone.

	IIII.	V.	VI.	VII.	VIII.	IX.	X.
Curtaine	36.	36.	36.	36.	36.	36.	36.
Face.	24	24.	24.	24.	24.	24.	24.
Surface.	23.18	22.62	22.17	21. 81	21,52	21.29.	21. 09
Gorge.	9.23	10.44	11.36	12,10	12.71	13. 22	13. 65
Throate.	13.05	16. 89	19.68	21. 81	23.48	24. 84.	25. 96
Capitall.	19. 73	20.73	21. 61	22. 38	23. 03	23.60	24.08
Extention.	26. 26	26.87	27.30.	27. 63	27.90	28. 12.	28. 30
Flanck.	7.74	8. 76	9.54	10.16	10.66	11. 09	11. 45
Second-flanck.	7.10	11, 27	12.98	13. 86	14.37	14.69	14.90
Flanck lengthned.	6,21	8. 01	9.18.	10.01	10, 61	11.08	11. 45
Defense fichant.	60.80	60.97	61. 11	61. 23	61. 33	61. 43	61. 51
Defense flanking.	53. 91	50. 24	48.92	48.35	48. 11	48.02	48.00
Polygone exteriour.	82. 36	81. 25	80. 35	79.63	79. 05	78. 58	78.18
Polygone interiour.	54. 45	56. 88	58. 73	60. 21	61. 42	62. 43	63. 30
Raid Majour.	58.24	69. 11	80. 35	91.75	103. 28	114. 87	126. 50
Raid Minour.	38. 50	48.38	58.73	69 37	80. 25	91. 27	102. 42
Distance of the Polyg.	13. 95	16.77	18.72	20.16	21. 28	22.17	22.90
				Angles			
Angle of the Polygone.	90.	108.	120.	128. 34$\frac{4}{7}$	135.	140.	144.
Angle flancked.	60.	69.	75.	79. 17$\frac{1}{7}$	82. 30	85.	87.
Angle flanking inten.	15.	19.30	22.30	24. 38$\frac{4}{7}$	26. 15	27.30	28.30
Angle flanking exter.	150.	141.	135.	130. 42$\frac{6}{7}$	127.30	125.	123.
An: forming the flanke	40.	40.	40.	40.	40.	40.	40.

A

DIMENSIONS OF TWO MANNERS.

The second manner is,

When the angle flancked is two thirds of the Polygone.

XI	XII.	*The curtaine right.*	IIII.	V.	VI.	VII.	VIII.
36.	36.	36.	36.	36.	36.	36.	36.
24.	24.	24.	24.	24.	24.	24.	24.
20.93	20.78	16.97	23.18	22.82	22.55	22.34	22.17
14.02	14.34	16.97	9.23	10.83	12.00	12.90	13.63
26.90	27.71	33.94	13.05	17.53.	20.78	23.26	25.19
24.50	24.88	28.97	19.73	20.40	21.10	21.75	22.32
28.46	28.60	28.97	26.26	26.77	27.10	27.37	27.53.
11.76	12.04	12.00	7.74	9.09	10.07	10.83	11.44
15.05	15.15	24.00	7.10	8.03	8.33	8.41	8.39
11.75	12.00	16.97	6.21	7.42	8.21	8.77	9.18
61.59	16.66	60.37	60.80	61.10	61.34	61.54	61.72
48.02	48.07	40.97	53.91	53.41	53.44	53.63	53.89
77.85	77.57	69.94	82.36	81.65	81.10	80.68	80.35
64.04	64.69	69.94	54.45	57.66	60.00	61.81	63.26
138.14	149.85	Infinite.	58.24	69.45	81.10	92.55	104.98
113.63	124.97		38.50	49.05	60.00	70.80	82.66
23.51	24.04	28.97	13.95	16.51	18.28	19.60	20.62
					Angles		
147.16$\frac{4}{11}$	150.	180.	90.	108.	120.	128.34$\frac{2}{7}$	135.
88.38$\frac{2}{11}$	90.	90.	60.	72.	80.	85.42$\frac{6}{7}$	90.
29.19$\frac{1}{11}$	30.	45.	15.	18.	20.	21.25$\frac{1}{7}$	22.30
121.21$\frac{9}{11}$	120.	90.	150.	144.	140.	137.8$\frac{4}{7}$	135.
40.	40.	35.16	40.	40.	40.	40.	40.

See the page going before & the explanation of the seuerall names.

A

F THE DIMENSIONS OF
FICATION IN TWO MANNERS.

re then the

The second manner is,

When the angle flancked is two thirds of the Polygone.

The curtaine right.

See the page going before & the explanation of the neere names.

VII.	VIII.	IX.	X.	XI	XII.		IIII.	V.	VI.	VII.	VIII.
36.	36.	36.	36.	36.	36.	36.	36.	36.	36.	36.	36.
24.	24.	24.	24.	24.	24.	24.	24.	24.	24.	24.	24.
21. 81	21. 52	21.29.	21. 09	20.93	20.78	16.97	23. 18	22.82	22.55	22.34	22. 17
12. 10	12.71	13. 22	13. 65	14. 02	14.34	16.97	9.23	10.83	12.00	12. 90	13. 63
21. 81	23.48	24. 84.	25. 96	26.90	27. 71	33.94	13.05	17.53.	20.78	23.26	25. 19
22.38	23. 03	23.60	24.08	24.50	24. 88	28.97	19. 73	20. 40	21. 10	21. 75	22. 32
27.63	27.90	28. 12.	28. 30	28.46	28.60	28.97	26.26	26. 77	27.10	27.37	27.53.
10.16	10.66	11. 09	11. 45	11.76	12.04	12. 00	7.74	9.09	10.07	10. 83	11. 44
13. 86	14.37	14.69	14.90	15.05	15. 15	24.00	7.10	8.03	8. 33	8.41	8. 39
10.01	10. 61	11.08	11. 45	11. 75	12. 00	16. 97	6. 21	7. 42	8. 21	8.77	9. 18
61. 23	61. 33	61. 43	61. 51	61. 59	16.66	60.37	60. 80	61.10	61. 34	61.54	61.72
48.35	48. 11	48.02	48.00	48.02	48. 07	40. 97	53. 91	53.41	53. 44	53.63	53. 89
79.63	79. 05	78. 58	78.18	77.85	77.57	69.94	82. 36	81.65	81. 10	80. 68	80.35
60.21	61. 42	62.43	63.30	64.04	64.69	69. 94	54.45	57. 66	60.00	61. 81	63. 26
91.75	103. 28	114. 87	126. 50	138. 14	149. 85	Infinite.	58. 24	69. 45	81. 10	92. 55	104. 98
69 37	80. 25	91. 27	102. 42	113. 63	124. 97		38. 50	49.05	60.00	70.80	82. 66
20. 16	21. 28	22.17	22.90	23.51	24. 04	28. 97	13. 95	16. 51	18. 28	19.60	20. 62
Angles									*Angles*		
128. 34$\frac{2}{7}$	135.	140.	144.	147. 16$\frac{4}{11}$	150.	180.	90.	108.	120.	128. 34$\frac{2}{7}$	135.
79. 17$\frac{1}{7}$	82. 30	85.	87.	88. 38$\frac{2}{11}$	90.	90.	60.	72.	80.	85. 42$\frac{6}{7}$	90.
24. 38$\frac{4}{7}$	26. 15	27.30	28. 30	29. 19$\frac{1}{11}$	30.	45.	15.	18.	20.	21. 25$\frac{5}{7}$	22. 30
130. 42$\frac{6}{7}$	127. 30	125.	123.	121. 21$\frac{9}{11}$	120.	90.	150.	144.	140.	137. 8$\frac{4}{7}$	135.
40.	40.	40.	40.	40.	40.	35. 16	40.	40.	40.	40.	40.

THE SECOND PART, TREATING OF THE FORTIFICATION OF PLACES IRREGVLAR.

BY

SAMVELL MAROLOIS,

Revewed, Corrected, & Augmented

BY

ALBERT GIRARD SAMIELOIS.

THE Fortification *irregular* being more variable by an infinite deale then the *regular*, is therefore more difficult and requireth for this cauſe much more judgment and diſcretion, for the effectuating of it well, and in chooſing the beſt way to make it then the former. Now to diſcuſſe thereof methodically me thinks it will not be amiſſe to beginn with the Fortification of a triangle *equilaterall*, that is, of equal ſides; which is well cõtained amonge the regular *Polygones*. And howbeit that their angles fall ſo litle and pointed, that they cannot be duely fortified as they ought: yet notwithſtanding, I think it beſt to beginn with them, as being irregular places, fortified noe otherwiſe then with a Wall or a ſmall Moate. But if the ground cann afford a good rampart, and a large moate; then I am of the opinion that ſometimes it wilbe requiſite, yea, and for the moſt part better, that one fortifies ſuch a place out of the encloſſure, then otherwiſe, as I hope I ſhall demonſtrate vnto you hereafter.

The 18 Plate & 84. Figure.

LEt then the triangle A, B, C, be Equiangle and Equilaterall, which ye would fortifie without diminiſhing of the place in any wiſe, nor yet enlarging it much. To doe this, we will divide the ſides of the triangle into 3 equall parts by the points F and D, and from the diſtance F, D, ſhalbe made the triangle Equilaterall D, F, E: the like muſt be done with the other triangles vpon the two ſides A, B, A, C, and ſo ye ſhall make a body *Hexangular*, built as a *tenaille*, without which ye maye make a moate of a competent bredth and capable for a place ſo fortified; and within the inſide, ye maye caſt vp a rampart of ſome 40, or 50 foote, as neceſſity ſhall require, all as appeareth by this preſēt figure. But if thē afterward, ye finde that the matter requires, that the angles exteriour maye be made, and reduced into Bulwarks, as then ye muſt follow our generall rule, giuen for our regular fortification, noted before in the 10, & 11 Plates, and ſhall draw the vtmoſt angles, to wit privie lines, as from G to A, then having reſolued to laye out the proportiō of the curtaine to the face, as 4 to 3. ye muſt vpon G, H, make 3 equall parts, and foure of the ſame parts from G tovvards A, as from G to A. from which point A from the diſtance of the 3 parts is made an arch towards I, and frō H an other arch of 4 parts towards the ſame point I. cutting the firſt at the point I. by which the line G. I. being drawne cutting H, A. at R. we haue A R. for the face, and by this meanes the ſaid face wilbe in like proportion to the curtaine as 3 is to 4: Now for to know the flanke, the Capitall line and the line of the gorge ye ſhall make an angle of 40 degrees through the line S. M. paſſing by the point R, and cutting the line *diagonall* (that is, vvhich extends it ſelfe from one corner to the other) at S. and ſo A S wilbe the Capitall line, S, T the gorge, T, R the flanke of the Bulwarke, and T, V, the curtaine, which hath the like proportion to A. R, as 4 to 3. And though this plote be not ſo well proportioned as is to be deſired: nevertheleſſe the defence thereof will fall out well, being dravvne from the midſt of the curtaine; but becauſe of the ſmallneſſe of the angles flanked, which are but 60 degrees, the gorge is very narrow, and the flank litle enoug: ſo that the ſaid bulwarke will beare noe cutting off; neither can containe men ſufficient to endure an aſſault: ſo that this manner of fortification, hath many imperfections, and ought not to be built in ſuch a ſort, when there is a commodious place to make it otherwiſe: yea it would be better to alter ſomewhat the angles by makeing them more blunt, and open, as in drawing the line Q. P. in ſuch wiſe, that the angle R. Q. P be 22½ degrees, and the face Q. R. comes not without the fortreſſe; then drawe the line P, R which giueth the length of the face Q. R, according to the method abouesaid, & the angle being made 40 degrees, you ſhall haue the capitall line Q, S, and R, T the flanke S, T the Gorge, & T V, the curtaine, which proportion is better then the former; becauſe the angle flanked is more open then the precedent, the Gorge larger, the flanke greater and ſtronger and of ſufficient ſtrength to reſiſt a furious batterie, ſo that by this meanes though the place will beare noe great alterations, yet it is made much better. Whence appeareth that by a litle change a fortification may be much bettered, without any great charge and labour, which ought not onely to be vnderſtood of this fortification; but alſo of all others, as wee hope ſhall appeare by the reſt.

How

How to fortifie a ſquare fortreſſe with a Tenaille.

Figure 85.

FIrſt ye muſt conſider, whither it were more fitting, to fortifie the angles of a quadrate, thē to fortifie it with a *tenaille*, which in my opinion ought to be done, when as the angles of the ſquare are ſo farre diſtant, that it is very needfull, to make a bulwarke in the midſt of the curtaine, then inſtead of building vpon the angles of the ſquare pointed Bulwarks, as commonly the quadrate Bulwarks are: I would make the angles B C D, F G H, K L M, & O P Q, in the midſt of the ſides of the ſquares, ſo that the lines, which forme the *tenailles* be all alike among themſelues, as A B C D E F G H &c, and the angles alſo equall one to another, which is done by drawing the two *diagonal* lines frō the quadrate, to wit, A I, N E, which cuts through each other in the center R. Then the diſtance A R being taken; and placed from A to D, from E to B, from E to H, and from I to F, and finally having made the angles D C B *Iſoceles* &c, from the diſtance D E, ye ſhall haue the figure *Octoangular* formed into a *tenaille*, whereof all the angles wilbe right, which afterwards may be made angles of the Bulwarks, when there is accommodation to make a *fort royall* thereof, & that the diſtance frō angle to angle, be about 80 rod; for if the right angles ſhould come much neerer then 40 or 50 rod, this would cauſe an imperfection, and ſuch a fortificatiō cannot be called a fort royall: ſo that in ſuch a caſe one ought to take adviſe, and conſider well, whither it were not better, to leaue ſuch a fortification in the former eſtate; then to alter it, becauſe the circuit of ſuch a place, will not be worth the time, labour & expēce, in regard the Bulwarks wilbe too litle, the lines too ſhort, and too weake to worke their effects: but if ſo be, the diſtance of the angles be capable to beare a perfect fortification thē ye maye make the plott as followeth. Let the line E G, be drawne, and divided into three equall parts at the poincts 1, 2. Then 2 of thoſe parts ſhalbe placed vpon H, G, as here at S. and from the points S. & I. of the diſtances I, G, and G, S, ſhalbe made the arches, which cutt through one another at the point 4; by vvhich the line G. 4. being drawne, where the ſame cutteth the line H, I, at the point 2, wilbe I, 2, the face, or the ſkirt of the Bulwarke. For to haue its flanke, the angle X V I muſt be made of 40 degrees by the line X V, paſſing through the point 2, & 5, and cutting the Diagonall G, R, in the point X, vvhich ſhalbe the center of the Bulwarke through vvhich point X a paralell line, being drawne to the line I G as X X, and from the point 2, drawing a perpendicular line vpon it, as Y 2, ye ſhall haue all the eſſentiall parts of this fortification, namely, the line I 2. ſhalbe the face, 2 Y the flanke: Y X the line of the gorge: Y T the curtaine; & Z I the line of defēſe flanking. According to vvhich the angles G, E, C, A, &c. being placed, ye haue the diſtance I. 2. and vpon the diſtance I, X, one may make the plot of ſuch a fortification, vvhich was firſt built into a tenaille, as appeareth by the two Bulwarks I & G, & nothing altered in all this fortification; but the lines of the tenailles 2. H. 5 placed vpon S T, T Y, & 2 Y, vvhich in all are but a litle longer then the abouesaid 2, H, & H, 5. Now the Earth vvhich is taken from the ſpace T 5, H 2, Y, is ſufficient to ſupply that deffect. The moate vvhich was made before, if it be broad and deepe enough, ye may leaue it as it was without makeing any alteration in it. And becauſe that in ſuch places, noe falſebrayes cann be made, but with great expence; in regard they are made on the outſide of the ramparts: and therefore one muſt make on the other ſide of the moate a good covert way, according to our former plots, that your men maye giue the bet-

ter reſiſtance to the aſſaillants. Moreover one maye (as appeareth by the figure 87 from 5 to H) make a good parapet, which ſhall run downe ſlooping about ſome 20, or 24 foote thick, and betweene H & 5 ſome traverſes, riſing one aboue an other, to lodge conveniently behinde them your musketiers, which maye giue fire vpon the paſſage to the moate, yea, ye maye make theſe traverſes in ſuch a manner that they maye eaſely plant two peeces of ordinance vpon them, that with them one maye beate vpon, and breake the Ennemies gallerie, when he ſhall offer to putt it into the moate, as alſo to defend the breach, when the aſſaulters ſhall attempt any thing vpon one of the Bulwarks, which maye be done not onely with the ſaid peeces: but alſo by the continuall ſhooting of the muſkettiers lodged in the ſaid traverſes, which would doe great ſpoile & could hardly be entred, becauſe the breach, having noe falſe bray vnder the bulwarke (as there can be none here) would make it more vnentrable, then if there were one. For the Earth of the rampart tumbling downe into the moate (which is deepe, would cauſe in my judgment the entrance to be more troubleſome, then if there were a falſe bray; ſeing an Ennemy ſhould be forced with great difficulty, danger, and loſſe of time, to damme and fill vp the ſaid moate, which is one of the chiefeſt obſervations of an Ennemy beſieged, to gaine time, and to hinder and forſlow his Ennemies approches, wherevnto me thinkes one ought moſt diligently to endeavour.

If one finds this manner of cutting off, good, which nevertheleſſe I will leaue to the judgment of Captaines experienced in the art militaire: it is manifeſt, that this fortification with a *tenaille* will be changed but a very litle, by the addition of Bulwarks, and ſo of leſſe expence: for the Ramparts 5. H. 2. ought to be made low, to the heigth required, and diminiſhed to the thickneſſe of 20 or 24 foote: ſo that all maye be done without any great loſſe, & time. But if the moats be ſo deepe, that one cannot from the flanke 5 ſee the botome of them, being dry, or elſe cannot diſcouver the ſuperficies of the water (if there be any) and that by the hindrance of the ſaid Earth, or parrapet 5. H, 2. It were in vaine to fortifie it, ſeing reaſon requires, that it ſhould be ſlighted: otherwiſe I ſee noe cauſe, that it ought to be taken away. For to beleeue, that the ſaid Earth might giue ſome advantage to the Beſiegers, that being paſſed over the moate, they might haue the better acceſſe to lodge in the ſaid place: the ſame maye be ſaid aſwell of a falſe braye, which nevertheleſſe is approued of the moſt expert Captaines; It is not likely then, that the ſaid Earth can cauſe any dammage, which might cauſe this to be left vndone.

To fortifie a Quadrilatera irregular in the forme of a trapeze.

Figure. 86.

LEt the *Trapezoide* (A fortreſſe of vnequall ſides) be A B C D, whereof the ſides A D are 69 rod, D C 45, C B 40, B A, 46: and the angle B 108 degrees (and conſequently C. 109: 10. D 71: 52, and A. 70: 50, and that ye would fortifie the ſame into a quadrangle.

To doe this, let there be deſcribed two Bulwarks vpon the angles B, C, the one being the angle of the *Pentagone*, and the other C approching, all in proportioning the gorges, flanks, and faces according to the diſtance B C, ſaying by rule of three, if 56,88 the *Polygone* interiour in the tables, giues the face 24, what will 40 rod giue, the ſide of the *Polygone* given B, C? the like doe with the flanke, gorge and

ſecond

ſecond flanke, according to which Dimenſions afterward the ſaid bulwarkes FGHIK,& LMNHE. are deſcribed.

And as the diſtance AD is two great, to deſcribe two Bulwarkes vpon the angles A,D, which may defend themſelues, becauſe this diſtance exceedeth our rules giuen heretofore,and the angles too litle: ye ſhall make or ordaine two Bulwarkes,as is ſeene in this figure, to wit, when as the ſaid diſtance AD is great enough,otherwiſe,ye muſt make but one Bulwarke,as we will ſhew you hereafter. But in this exemple, the flankes of the aboueſaid Bulwarks 1. 2. 3. 4. ſhalbe made perpendicular lines vpon AD.and ſo farre lengthned from the angles AD, that there be meanes to defend the ſaid flanks 1. 2.3. 4. ſo that indeed the two Bulwarks aboueſaid,are but in effect as Demy-Bulwarks, whereof their angles 1.3. make 70. degrees,and are defended from one ſide of the curtaine,as a *Pentagone* is defended, and from the other ſides,are the flanks of the ſaid Curtaines 2.A & 4.D defended: ſo that the flanks 1.2.& 3.4. are alſo ſufficient to defend the two lengths A.2. & 4.D. & for aſmuch as it is to be doubted,that the neerer one approches to the aboueſaid flanks of the ſaid angles A & D.that they wilbe in the moſt danger to be ruined: It wilbe good,to draw back theſe flanks of the ſaid angles,at the leaſt ſome 400.foote, that they maye not be beaten downe with Canon; on the otherſide, ye muſt take heede that the flankes 1. 2. & 3. 4. be not made too great, nor too farre aſſunder from the ſaid angles A.&D. that the lines of defence coming out of the curtaine be made in the ſame ſort, as the defenſes of the *Pentagone* are,as is ſeene vpon the curtaine B.C. And as the diſtance A.D.is in this exemple but 69 rod makeing there in 2 Bulwarks: it followeth neceſſarily,that the diſtances 2 A: 4.D. alſo the flanks, and the faces of the ſaid Bulwarks be much more leſſe, then our former plateformes,will beare:in ſuch ſort,that the parts A 2 &4 D are but 15 rod,& the flanks 2.1,& 4 3, onely ten rod; becauſe that otherwiſe the line of defenſe cannot come out of the curtaine F. G. as here from the point O, which of neceſſity muſt be made to defend the face K,3. Afterward the face 3 K. being made 12 rod, the flanks K.G. and V,F, wilbe about 7 rod,from the ſide C.D. ye ſhall draw a paralell of 10 rod,and the inſtrument being opened of 70 degrees, it muſt be moued ſo much, that the line of defenſe M. T. maye come a litle out of the curtaine EP: the flank PQ. being made equall to EH. ye haue the demy Bulwark P.Q. MN. The like is to be done vpon the ſide A.B,and ſo this place wilbe fortifyed, according to our intention,and in the ſame manner,as the figure 86 demonſtrateth:and though the Bulwarkes be very ſmall: notwithſtanding by this meanes the angles A,& D, wilbe well preſerued; and the one will defend the other directly. And when as the diſtances C.D. are but 45 rod: one maye in ſome wiſe from the flanke defend the angle D. But when the flanke is noe more then $6\frac{2}{10}$ rod,one ought rather to make the *demy Bulvvarke* P.Q. M.N,having the flanke NM.10 rod,which is more capable to defend N.D. then is E.H,yet with this caveat,that the diſtance ND be not too litle: for then by reaſon of the thickneſſe of the parapet, it will be impoſſible to diſcouver ND. if the demy-Bulwarke PQ. M.N. be not made lower then the curtaine C. D. and in ſo doing ſuch an inconveniency maye be prevented: the like is tobe vnderſtood of the Bulwarks placed vpon the curtaine A.D.

An other way.

The 19. *Plate,and* 88. *Figure.*

NOwin ſuch a fortification, which hath but one ſimple defenſe, the angles of the *tenaille* maye lightly be taken in, becauſe that in the figure 86 NM.& N.

D. are ſo ſhort : It were better in my opinion , to fortifie the ſaid figure in this forme following.

Let there be made vpon the longeſt ſide the Bulwarke 1,2,3,4,5,6, proportioned according to the lenght A.6. the halfe of A.D, and of the nature of the *Dodecagone*, whereof the gullet (which is the diſtance from the one flanke to the other) maketh 27.71.and the capitall line drawne from the angle thereof through its center perpendicular vpon the ſaid line from flank to flanke,called extended,maketh 28. 59. as appeareth by the table here to fore many times repeated, which is the cauſe of the obliquitie of the flanks vpon the ſaid curtaine, A D, for ſeing that the *Dodecagone* hath the angle in the circumference of 150 degrees , the flanks will fall perpendicularly vpon the ſides,and conſequently the ſame flanks will make vpon the ſaid curtaine A,D,an angle of the halfe of the angle of a *Dodecagone* , which is 150 degrees,makeing for euery angle of the flanke 75 degrees , and as much will the angles A 12, & 45. D make. The reſt of the Bulwarke in noe wiſe changes the proportion. To knovv then the Capitall line 6,3. you ſhall ſay by the rule of proportion : If the curtaine interiour and exteriour, vvhich are here alike contayning 70 rod, in a right curtaine giving 28. 59. rod, for the capitall line extended, vvhat vvil 34½ rod, the length A.6. giue? that vvhich it vvill bring forth,to vvith 14. 9,is the capitall line,6,3.for the face ye ſhall ſay:if 70 the ſide of the *Polygone* interiour or exteriour in a right curtaine(which are equall)giueth for the face 24,what vvil the ſide of the *Polygone* A.6.34½ rod,giue? ye ſhall haue for the face 11,83 rod, which being placed from 3 to 4, & from 3 to 2 (firſt the angles 6.3.4.& 6. 3 2. being made of 45 degrees, becauſe the vvhole angle 2.3.4 makes 90 degrees by Hypotheſis) ye ſhall ſett the tranſporter vpõ 15 degrees,and ſhall make the lines 1.2&4.5 of ſuch an inclinatiõ,that ſhall forme the flanks,according to the proportion required,and by the ſame meanes ſhall be knowne the gullet 1. 5. which may be found likewiſe by the former rule of proportion,in ſaying:if 70 giueth 1385 (the halfe of 27.71)vvhat vvill 34½ rod giue for A.6? that vvhich this rule vvill produce ſhalbe for 1. 6. or 6. 5. After the ſame manner muſt ye make vp the Bulvvarks,E,F,G,H,I,& S,T,V,W,X. deſſigned in the midſt of the ſides A,K,& R,P,according to their length. But before they are layd out, the tvvo ſides A B,& C,D,ought to be lengthened ſo farre, that one maye make the angles B,K,L & C,R,P,of 75 degrees, and that the line of defenſe O,K. termineth in the curtaine M. Q. and to knovv the length of the faces and flanks,the face ſhalbe made double in the flanke, which is done if ye place vpon the perpendicular O N , the halfe of the line of Defenſe O K.as from O to N. and from the point K,the privie right line N K, being drawne,cutting through the line C,B, at M, ye ſhall dravv the line M,L, paralell to N, O, or perpendicular vpon C,B, and ſo the flanke L,M, vvilbe the halfe of the face L,K. And thus vve haue finiſhed the fortification of the abouesaid *Quadrilatere* irregular , vvhich in my opinion is a better fortification , then the precedent figure 86.becauſe theſe Bulvvarks are more capable to defend the angles A, D, K, R, and the flanks of the ſaid Bulvvarks being dravvne *obliquely*,as they are here , cannot be made into right angles : in ſuch ſort,that they are the better able to reſiſt againſt the force , vvhich maye be vſed againſt them,and yet make a good defenſe , as the figure 88 plainely demonſtrates.

An

An other way to make the fortification of ſuch a place regular.

The 19. *Plate and* 89. *Figure.*

FIrſt of all vve vvil deſcribe the quadrate E F. G H. after ſuch a manner that the line E F is paralell to A. D. & of the greatneſſe of the *poligone* exteriour ; in the followving table of lengths: dravving the paralell E,F, ſo, that its diſtance A, D, be equall to the diſtance of the *Polygons*, aſvvel interiour as exteriour, to the intent, that the ſide of the *Quadrilatere* A, D, may ſerue for the curtaine. Then the angles I,F,E,& I,E,F, being made 15 degrees (becauſe the angle interiour flanking is of 15 degrees in the ſquare) ye ſhal take vpon a ſcale 5. equall parts & place them vpon the line F,E, and foure of the ſame parts vpon the line F,I. from the extremity (or vtmoſt end) vvhereof and with the ſaid diſtances ye ſhall make two arches, that ſhall cutt through one an other at X, drawing from thence a line to F, cutting through the line, I E, at G. then E,G, wilbe the face of the Bulwarke , which will haue the like proportion to the curtaine, as 4 to 5. But wee will hete after in all the kinds of Polygones, ordaine the curtaine to the face in proportion as 3 to 2. that is *ſeſquilatera*, finding it beſt, as we haue ſaid before. After wards, to haue your flanks ye muſt make two perpendicular lines G N. and H K, vpon the ſide A. D. in ſuch manner, that the lines G N and H K, ſhalbe the flanks, and N K the curtaine, which is part of the ſide A D. The like ye ſhall doe with the three other ſides, and ſo by this meanes this fortification wilbe made *regular*, and *royall*, which will not coſt much more, then the former irregular fortification aboueſaid, the benefit whereof ſurpaſſeth the others by farre: ſo that in ſuch like accidents, I am of the opinion, that ſuch places ought to be made regular, in caſe that time, and the ſituation wil permit it : As for the moates, ramparts, and parapets , they muſt be made as wee haue taught in the places of regular fortifications.

The fortification of a Pentagone irregular.

The 19. *Plate and* 90. 91 *Figures.*

LEt the *Pentagone* irregular be A,B,C,D, E, which one would haue fortified in ſuch ſort, that the Bulwarks come againe to the angles of the propounded figure ; To doe this, ye ſhall firſt meaſure the outſides, and the angles , which I ſuppoſe ye ſhall finde to be as they ſtand here vnderneath.

	rod
A B	57.
B C	50.
C D	46.
D E	56:

	degrees
A	72.
B	135.
C	111.
D	97.
E	125.
	540.

And ſeing the angle A, is leſſer then 90 degrees, reaſon requireth that the ſaid angle be not fortified; becauſe it would make an angle flanked, leſſer then 60 degrees, and flanking greater then 150 degrees, againſt our former *maximes* , according

ding to which ye ſhall make of the ſame angle A. an angle of the bulwarke, makeing the angle of the Polygone F. ſo that the right lines F G, and F I, come to cutt through the lines lengthned B C, D E, in the points G and I. Vpon the angles whereof, and according to the proportion of the ſides ſhalbe deſcribed the Bulwarks, takeing heede, that the angle of the *Polygone* ſhow what forme of a Bulwarke one muſt built vpon, to wit, a *Quadrate*, a *Pentagonall* or an *exagonall*, proportioning out the parts of ſuch a Bulwarke, according to the leaſt ſide of the two, and then the figure wilbe deſcribed, according to this preſent forme: And ſeing the ſide D E (becauſe it hath ben lengthned) is longer, then the proportion can beare of our regular figurs precedent: It wilbe neceſſary, that betweene the two Bulwarks D & E, a Ravelin be made, which is a looſe peece, that maye be defended at leaſt vviſe from the flanks of the abouesaid tvvo Bulvvarks: according to vvhich flank, the angle of the Raveline ſhalbe made a litle more open, or cloſſer as the curtaine is either longe, or ſhort. The faces vvhereof ſhalbe made of 18 or 20 rod, ſometimes a litle leſſer, as the place and ſituation of the ground requireth. And to giue you to vnderſtand more clearely my intention touching the fortification of places irregular, vvhereof the angles are noe leſſe then 90 degrees, which is the angle of a *Quadrate*, and that the ſides doe not differ much from thoſe places vvhich are regular: It muſt be proportioned thus: Suppoſe that one giueth me the angle C to be fortified, of vvhich the magnitude is 111 degrees, vvhich comes neere the angle of a *Pentagone*, according to vvhich I take the ſhorteſt line of the tvvo B C, & C, D, makeing therevvith the angle B, C, D, vvhich is C. D. contayning 46 rod, we wil ſeeke out then in the table of the lengths of our regular fortifications, the dimenſions of a *Pentagone*, and will ſay by the rule of proportion, if a Polygone 56,88 giueth the face 24, vvhat vvill then a Polygone of 46 rod giue? ye ſhall haue for the face 19.41 rod. The like ye ſhall haue for the flanke, and then the Gorge, where by ye ſhal finde the ſaid Bulvvarke C. as alſo all the other parts of this fortreſſe *Pentagonall*: holding this for an infallible rule, that the angles of the *Polygone*, which you would fortifie ought to be at the leaſt right, and in caſe there be any angle that hath a leſſe opening, then the right, ye muſt make thereof the angle of a Bulwarke or elſe dravve a line (if you cannot leſſen the place) vvhich vvill forme an angle competēt to builde a Bulwarke vpon, as appeareth by the 90 figure in the angle A. Which line you muſt ſo huſband, that if it be poſſible it maye be made equall to that, vvhich ſhall come to cutt through it, that ſo yee maye haue a nevv angle, vvherevpon ye maye make likevviſe an other Bulvvarke, euen as the ſaid figure F, G, C, D, I, demonſtrateth, and if the lines exceede by much the length of the *Polygones* interiour, then ye ſhall take them for ſides of the *Polygones* exteriour, in tracing out the ſaid fortreſſes vvithin them, & that according to the kinde of euery angle F, G, C, D, I, and in ſo doing your *Pentagone* vvilbe fortified.

An other way.

The 19 Plate & 91 Figure.

LEt the *Pentagone* be A, B, C, D, E, vvhich you deſire to fortifie after an other manner then aboue: for the effecting of this, ye ſhall prepare the angles of the Bulvvarks, according to the ſcale of the figure, that you vvould haue fortified, ſuch as before ye haue traced out, all ſeparated one from an other, as they are marked out in the 21 Plate by the numbres 97, 98, 99, 100, 101, vvhich angles ſhalbe placed vpon

pon the angles of te figure to be fortified, obſerving wel by what meanes the aid place maye be beſt made vp & with the leaſt expenſes, according to our former *Maximes*, and to that end, if it be ſoe that the place be girt about with a wall or rampart, and that ye would make as much vſe of it, as poſſible might bee for the aving of charges the which (though ye help your ſelf with the old fortification) is lwaies great enough, at the leaſt ye muſt labour, that the ſides of the *Pentagone* e accommodated betweene the two Bulwarks, to ſerue as a curtaine, as we haue lone in the figure 91. where wee haue placed in the angle A (which is leſſe then 90 degrees) the angle of a *Pentagone*, or elſe the Bulwarke of a *Pentagone*, that maye e removed ſo long till ye ſhall finde the buyſineſſe, and the diſpoſition of the place equired drawing from the center of the ſaid Bulwarke F, two lines, as F, G, & F, I, erving for curtaines, and meeting with the other two ſides of the *Pentagone* engthned in the points G, & I. Vpon which angles G, C, D, I, ye ſhall forme after ur former rule (, to wit, according to the angles and the ſides) the Bulwarkes pon them, and if ye finde, that the ſides are ſomewhat longer, then our precedent ules approue of, in the midſt thereof we will caſt vp a good Raveline as wee haue lone here betweene the two Bulwarkes D & H, and take this for a generall rule, hat your Bulwarks ought not to be any further aſſunder then ſome 60 rod, or hereabouts, to wit, that the line of defenſe *fichant*, be of this length or neere vpon t. If it be ſo, it would not be needefull otherwiſe to make a Raveling, but when as the ſaid line exceedeth by much the ſaid meaſure, then is it wholly neceſſarie, hat the ſaid Raveline be placed in the midſt, betweene the two Bulwarkes aboue-aid, to ſupply thereby the defect of the ſaid line, & the better to blinde the flanks hich by that great diſtance would lye very open.

Another way.

The 20. Plate & 92. Figure.

IF the place permits to alter the angles a litle, then the fortification wilbe the better, as is ſeene in the *Pentagone* A, B, C, D, E, which is the ſame with the former, where the angles of the Bulwarks are changed, and ſome faces of them vnequall, and ſo by this meanes the Bulwarks will not be too farre diſtant one from another, as this preſent figure 92 demonſtrateth. But in ſuch a caſe ye are conſtrained that the curtaines comes or runns a litle out of the ſides of the *Pentagone*, and ſometimes cuts through them, as the ſame figure ſheweth, and ſeing it were hard to trace out this figure ſo without ſome direction, ye ſhall make vſe (as vve haue ſaid before in the 19 Plate) of Bulwarks cutt out in paſtboord, marked in the 21 Plate, according to the ſpace of the angle, vvhich ye vvould fortifie as vve haue done heere; for the angle A being 72 degrees, ye ſhall make vſe thereof, then comming to B, and finding it to be the angle of an *Exagone*; I take the Bulvvarke of the *Exagone*, and place it at B, turning and removing it ſo long, till the line of the *traille* comes to cutt through the line A B, as here at O. makeing A, O, and O, F, equall, that the defenſe maye be made thereby alike: for I am of the opinion, that the tvvo faces, flanks, and lines of defenſe ought to be equall among themſelues, becauſe they muſt neceſſarily defend each other alike: ſeing the defenſe cannot be vnequall vvithout diminiſhing the force of the one or of the other, vvherevnto ye muſt take ſpeciall heede, as much as poſſibly may be, to hinder ſuch an irregularitie, that the one receiue noe preiudice by the other, and ſo the faces F, H, and

ding to which ye ſhall make of the ſame angle A. an angle of the bulwarke, i keing the angle of the Polygone F. ſo that the right lines F G, and F I, come to c through the lines lengthned B C, D E, in the points G and I. Vpon the ang whereof, and according to the proportion of the ſides ſhalbe deſcribed the B warks, takeing heede, that the angle of the *Polygone* ſhow what forme of a B warke one muſt built vpon, to wit, a *Quadrate*, a *Pentagonall* or an *exagonall*, pr portioning out the parts of ſuch a Bulwarke, according to the leaſt ſide of t two, and then the figure wilbe deſcribed, according to this preſent forme: An ſeing the ſide D E (becauſe it hath ben lengthned) is longer, then the propo tion can beare of our regular figurs precedent: It wilbe neceſſary, that betweer the two Bulwarks D & E, a Ravelin be made, which is a looſe peece, that maye b defended at leaſt vviſe from the flanks of the abouеſaid tvvo Bulvvarks: accordin to vvhich flank, the angle of the Raveline ſhalbe made a litle more open, or cloſſe as the curtaine is either longe, or ſhort. The faces vvhereof ſhalbe made of 1 or 20 rod, ſome times a litle leſſer, as the place and ſituation of the ground requi reth. And to giue you to vnderſtand more clearely my intention touching th fortification of places irregular, vvhereof the angles are noe leſſe then 90 degrees which is the angle of a *Quadrate*, and that the ſides doe not differ much from thoſ places vvhich are regular: It muſt be proportioned thus: Suppoſe that one giueth me the angle C to be fortified, of vvhich the magnitude is 111 degrees, vvhich comes neere the angle of a *Pentagone*, according to vvhich I take the ſhorteſt line of the tvvo B C, & C, D, makeing therevvith the angle B, C, D, vvhich is C. D containing 46 rod, we wil ſeeke out then in the table of the lengths of our regula fortifications, the dimenſions of a *Pentagone*, and will ſay by the rule of proportior if a Polygone 56,88 giues the face 24, vvhat vvill then a Polygone of 46 rod giue? ye ſhall haue for the face 19.41 rod. The like ye ſhall haue for the flanke, and then th Gorge, where by ye ſhal finde the ſaid Bulvvarke C. as alſo all the other parts of thi fortreſſe *Pentagonall*: holding this for an infallible rule, that the angles of the *Poly gone*, which you would fortifie ought to be at the leaſt right, and in caſe there be any angle that hath a leſſe opening, then the right, ye muſt make thereof the angle of a Bulwarke or elſe dravve a line (if you cannot leſſen the place) vvhich vvill forme ar angle competēt to builde a Bulwarke vpon, as appeareth by the 90 figure in the an gle A. Which line you muſt ſo huſband, that if it be poſſible it maye be made equal to that, vvhich ſhall come to cutt through it, that ſo yee maye haue a nevv angle, vvherevpon ye maye make likevviſe an other Bulvvarke, euen as the ſaid figure F, G, C, D, I, demonſtrateth, and if the lines exceede by much the length of the *Polygones* interiour, then ye ſhall take them for ſides of the *Polygones* exteriour, in tracing out the ſaid fortreſſes vvithin them, & that according to the kinde of euery angle F, G, C, D, I, and in ſo doing your *Pentagone* vvilbe fortified.

An other way.

The 19 Plate & 91 Figure.

LEt the *Pentagone* be A, B, C, D, E, vvhich you deſire to fortifie after an other manner then aboue: for the effecting of this, ye ſhall prepare the angles of the Bulvvarks, according to the ſcale of the figure, that you vvould haue fortified, ſuch as before ye haue traced out, all ſeparated one from an other, as they are marked out in the 21 Plate by the numbres 97, 98, 99, 100, 101, vvhich angles ſhalbe place

vpon

vpon the angles of te figure to be fortified, obſerving wel by what meanes the ſaid place maye be beſt made vp & with the leaſt expenſes, according to our former *Maximes*, and to that end, if it be ſoe that the place be girt about with a wall or a rampart, and that ye would make as much vſe of it, as poſſible might bee for the ſaving of charges the which (though ye help your ſelf with the old fortification) is alwaies great enough, at the leaſt ye muſt labour, that the ſides of the *Pentagone* be accommodated betweene the two Bulwarks, to ſerue as a curtaine, as we haue done in the figure 91. where wee haue placed in the angle A (which is leſſe then 90 degrees) the angle of a *Pentagone*, or elſe the Bulwarke of a *Pentagone*, that maye be removed ſo long till ye ſhall finde the buy ſineſſe, and the diſpoſition of the place required drawing from the center of the ſaid Bulwarke F, two lines, as F, G, & F, I, ſerving for curtaines, and meeting with the other two ſides of the *Pentagone* lengthned in the points G, & I. Vpon which angles G, C, D, I, ye ſhall forme after our former rule (to wit, according to the angles and the ſides) the Bulwarkes vpon them, and if ye finde, that the ſides are ſomewhat longer, then our precedent rules approue of, in the midſt thereof we will caſt vp a good Raveline as wee haue done here betweene the two Bulwarkes D & H, and take this for a generall rule, that your Bulwarks ought not to be any further aſſunder then ſome 60 rod, or thereabouts, to wit, that the line of defenſe *fichant*, be of this length or neere vpon it. If it be ſo, it would not be needefull otherwiſe to make a Raveling, but when as the ſaid line exceedeth by much the ſaid meaſure, then is it wholly neceſſarie, that the ſaid Raveline be placed in the midſt, betweene the two Bulwarkes aboue-ſaid, to ſupply thereby the defect of the ſaid line, & the better to blinde the flanks which by that great diſtance would lye very open.

Another way.

The 20. Plate & 92. Figure.

IF the place permits to alter the angles a litle, then the fortification wilbe the better, as is ſeene in the *Pentagone* A, B, C, D, E, which is the ſame with the former, where the angles of the Bulwarks are changed, and ſome faces of them vnequall, and ſo by this meanes the Bulwarks will not be too farre diſtant one from an other, as this preſent figure 92 demonſtrateth. But in ſuch a caſe ye are conſtrained that the curtaines comes or runns a litle out of the ſides of the *Pentagone*, and ſometimes cuts through them, as the ſame figure ſheweth, and ſeing it were hard to trace out this figure ſo without ſome direction, ye ſhall make vſe (as vve haue ſaid before in the 19 Plate) of Bulwarks cutt out in paſtboord, marked in the 21 Plate, according to the ſpace of the angle, vvhich ye vvould fortifie as vve haue done heere; for the angle A being 72 degrees, ye ſhall make vſe thereof, then comming to B, and finding it to be the angle of an *Exagone*; I take the Bulvvarke of the *Exagone*, and place it at B, turning and removing it ſo long, till the line of the *tenaille* comes to cutt through the line A B, as here at O. makeing A, O, and O, F, equall, that the defenſe maye be made thereby alike: for I am of the opinion, that the tvvo faces, flanks, and lines of defenſe ought to be equall among themſelues, becauſe they muſt neceſſarily defend each other alike: ſeing the defenſe cannot be vnequall vvithout diminiſhing the force of the one or of the other, vvherevnto ye muſt take ſpeciall heede, as much as poſſibly may be, to hinder ſuch an irregularitie, that the one receiue noe preiudice by the other, and ſo the faces F, H, and

A L. wilbe equall, but F H, wilbe vnequall with F G. the ſecond face of the bulwarke H, F, G, and yet ſo, that the ſaid inequality cauſeth noe great hindrance to its forme, and force. For firſt the face H, F, cannot be made noe longer; in regard of the diſtance A, F, which maye not be much augmented, vnleſſe the Curtaine M, N, comes much out of the line B, C. Alſo the line A, F, cannot be augmented vnleſſe conſequently the line, or diſtance F, C, be not more and more augmented ſo that alwaies the ſame difficultie remaines, to wit, that the Bulwarks F, & I. wilbe of a greater diſtance then the Bulwarks F, & A, and thus the diſtances differing, will make alſo differing faces, curtaines, and flanks: for according as the ſpace is great betweene F, I. ſo ye muſt haue more men to defend it, then if the place were leſſer. Now ſeing this defenſe cannot be made more commodiouſly, then from the faces of the Bulwarks: It is moſt certaine that the faces ought to be augmented more then the former: Yet never the leſſe without paſſing the limits of the former plots in our regular fortification, vvhich haue their faces about 24 rod, ſome more ſome leſſe: but if they be much longer, then the lines of defenſe vvilbe of ſuch a large extent, that it vvilbe almoſt impoſſible to make any vſe and profite of them. For vvhich reaſon I haue thought fitting to make the augmentation of the faces F, G. & K, I. according to the diſtance F, I, remayning notwithſtanding within the bounds of regular fortification; and within the compaſſe of the maximes grounded therevpon, vvritten before. And ye muſt note beſides, that the interiour angle flanking F, A, L, or A, F, H, muſt never be leſſe then 15 degrees: and obſerue alſo, that the more open this angle is, the more cloſſer the angle of the *tenaille* vvilbe, and conſequently the better. But ye ought on the other ſide to take heede, that the angle F, A, L, being large and open, the line A, F. be not lenghtned to farr from the bodie of the figure to be fortified: ſo that herein ye muſt vſe diſcretion requiſite in ſuch a caſe, and ſo accommodate the ſaid bulvvarks cutt out in paſtboord that the ſaid angles be tolerable, and that on the other ſide the curtaines be not too farre diſtant from the ſides of the *Polygone* as B. C. & C. D, and as this figure repreſents it to your eye.

Yet an other way.

The 20. Plate & 93. Figure.

IF you are deſirous that the flanks of the Bulvvarks B, & C, fall vpon the ſide of the *Polygone* B, C, ſo that the part G, H, maye ſerue for a curtaine; you muſt doe as followveth, the angle B, A, F, is made of 15 degrees, becauſe that in makeing it greater, the line F A vvould runne too farre from the place A, B, C, D, E: thē ye ſhall make the line *paralell* F, G, diſtant from the line B, C, as farre as the *Polygone* exteriour is diſtant from the *Polygone* interiour, in the *Pentagone*; becauſe that the angle G, ought to be *Pentagonall*, and if the line F, G, is ſhorter, then the *Polygone* exteriour in our table of lengths; ye ſhall finde out a proportionable diſtance, in ſaying: If the ſide of the *Polygone* exteriour 8125. giueth diſtance to the *Polygones* 1677 vvhat diſtance vvill F G, giue, that vvhich this rule wil produce ſhalbe the diſtance of the paralells B, C, & F, G, and ſo conſequently the paralell F, G, being made, from that diſtance ye haue the thing required, and before ye beginne vvith the Bulvvarks, it is your beſt vvay to make the lines G H, H I, & I A, and as the line B, C. hath ſerued for a curtaine, the line C, D, maye ſerue for the moſt part thereto, ſeing that the line G H, is not ordinarily paralell to the ſide of the *Polygone* irregu-

lar,

lar, C,D, but the ſide E,D, maye be accommodated as before : ſo that one part of it vvill ſerue for a curtaine to the two Bulwarks; which ſhalbe made in the angles I. & H. ſo that if the angle D,had not ben ſo ſharpe,and that the line G,H, might haue bene paralell to E,D, it is evident, that one could haue made vſe of C,D, for the curtaine of the tvvo Bulvvarks, G & H. Or elſe if the line F,G,might haue bene ſomevvhat augmented,the curtaine would haue falne much neerer to C.D : But ſeing in this exemple it could be noe longer,of neceſſity the ſaid curtaine muſt fall vvithin the inſide of the figure *Pentagonall* irregular. Then having dravvne theſe your lines A,F,G,H,I vvith all circumſpection requiſite,to vvit,that the angle flanking interiour be at the leaſt 15. degrees:ye ſhall draw out vpon them the Bulwarks, flanks,and curtaines,in ſuch ſort,that the faces & flanks of the Bulwarks, vvhich are vpon the one ſide of the *Polygone*, be alike amonge themſelues, as thoſe vvhich are noted in the 92. Figure, & according to our former rules giuen in our regular fortifications.

A way how to fortifie a right Curtaine.

The 20. Plate & 94. Figure.

IF it be needefull to fortifie a right Curtaine, vvhereof the angles of the Bulwarks are right,ye muſt doe as followeth. Let there be taken 70 rod,wanting 6 ſeconds (that is 69. 64. rod) and putt vpon the ſaid curtaine A, E, as many times as the ſaid curtaine will beare it, as appeareth here by the points A, B, C, D, E, from vvhich points ſhall riſe the privie perpendiculars A F, B G, C H, D I, & E K the Capitals of 28, 97. rod,and on each ſide of the ſaid points A,B,C,D,E, ſhalbe placed 16, 97. rod, as from A, to L. and at M, rayſing the perpendiculars L,N,and M, O, 12 rod,the flanks 6,11: then the lines N F,and F O,being drawne,vvhich vvill make the faces of the Bulwarks, ye ſhall haue that which is neceſſarie for the deſcription of ſuch a Bulwarke, whereof the face is 24, rod,the flanke 12. the line of defenſe fichant 60,37,and the line of the gorge L,A, 16.97, rod. The moate maye be made broader,ſeing that the angle of the *Tenaille* Z hindreth,that the angle of the flanke T, cannot diſcover the angle flanked F : but if the expence vvere not too much (which hapneth vvhen one makes the moate very deepe) one might to that end cut the part X,Y,Z,and ſo this inconveniencie vvould be remedied. For I finde that ſuch Bulwarks are farre better,then thoſe that are made vpon an angle ; becauſe the gorge is very large ; the flank,the face,and the curtaine of a competent meaſure,and according to our former rules,to wit,the line of Defenſe fichant is 60 rod,or thereabouts,the Curtaine 36,the flank 12,the face 24,and the gorge wel nigh 17,rod,which is much better,and larger,then in the Bulwarks,that are made vpon ſome angle. So that ſuch Bulwarks ought to be preferred before the others, were it not for ſome other reaſon,which makes one change his minde,as for to haue more place, or otherwiſe. Novv touching the diſtance of Bulwarks, or a *Polygone* interiour mentioned of 70 rod vvanting 6 ſeconds,theſe 6 ſeconds are of noe great moment : nevertheleſſe one muſt obſerue the dimenſion as neere as poſſible maye be : Otherwiſe one might ſay,that the *face* being 24, the curtaine 36, the *flank* 12, rod,and the *angle flanked* right,that then the *Capitall* wilbe wel nigh 29,*the gorge* 17,the *defenſe flanking* 41. *the line* of the *Poligone* interiour, or exteriour 70. rod, the formed-flanked is 35 degrees,and 16 minutes.

How to fortifie a Hexagone irregular.

The 21. Plate, & 95, 96. Figure.

LEt the figure *Hexagonall* to be fortified, be A, B, C, D, E, F, vvhereof the length of euery ſide maketh as many rod, as they are marked out, to vvit A B. 70: B C. 132: C D, 114: D E. 80: E F, 124: & F A, 176 rod. To doe this, ye muſt take notice of the angles thereof, and as their greatneſſe is ye ſhall order the angles of the Bulvvarks, according to their formes. And for as much as the angles A & F, are but 108, & 110½ degrees, vvhich are the angles of a *Pentagone*, it vvilbe good to make there the angles of demy-bulvvarks, to haue the angles more open, and the angle of the Tenaille more cloſſer, and conſequently better. Vpon the curtainè F A, ſhalbe placed tvvo Bulwarks G & H, of a competent greatneſſe to the curtaines, proportioning out the *Capitall lines*, the *gorges*, *flanks* and *faces*, according to the greatneſſe of thē, & as we haue ſaid before in ſaying: If 70, (which is the diſtāce of each angle, or the center of the Bulvvarks, giues for the Capitall line 28, 97. what will the diſtances of the centers of the bulvvarks giue? that vvhich this rule will produce vvilbe the *Capitall line*, and in the like manner ſhall ye finde the line of the *gorge*, *the flank*, and *the face* of the Bulvvarks H, &, G, the Bulwarke I ſhalbe made in the midſt of the curtaine M, N. or in the midſt of the line E, F, and for aſmuch as the angle E, is of 112. degrees, vvhich comes neere vpon the angle of a *Pentagone* ye ſhalbe vpon the foreſaid angle E deſcribe the angle of a *Pentagone*, and ſeing that the line E. D makes 80 rod, vve vvill make the angles flanking interiour of the forme of a *Pentagone*, to the end, tha the ſkirts E, L. and D, O. be equall, as we haue ſaid before: for ſeing the Ennemies force betvveene E & D is equall, reaſon requireth that the defenſe thereof be likewiſe made equall, that by this meanes, ye maye take away all occaſion from an Ennemie to attempt any further place the moſt advantagious for him. Now in regard that the diſtance D. C. exceedeth the meaſure, vvhich wee haue ſpoken of before, to wit, of 114½ rod, it vvilbe neceſſarry to make the Raveline K, betweene the ſaid angles D, & C, to ſupply the defect of the defenſe: the like maye be made betweene C, B, and the angles of the Bulwarks, and B, the reſt ſhall be made according to their formes & *the faces*, *flanks* and *Curtaines* in that forme, as vvee haue ſaid aboue, euen as this figure Hexagonall 95. demonſtrateth.

The 96. Figure.

HErein it is requiſite to note, that vvhen one is bound to fortifie preciſely the angles of the figure, either interiourly, or exteriourly, ye meete many times vvith difficulties: to vvit, here are ſome angles or ſides too ſmall, and others too great; in ſo much, that this irregularitie maye cauſe many great defects. Which maye greatly be remedied, vvhen ye maye haue libertie, to change a litle the angles of the figure, euen as wee haue done in this 96. figure, in ſuch ſort, that the angle E, being but 112. degrees, which is the angle of a *Pentagone*, makes the angle of the bulwark S, E, T too much pointed, as when ye would make it on the inſide of the angle E. Therefore, ſee that ye make the face E, S, vpō the ſide E D, that by this meanes, ye maye haue the angle S, E, T, broader and more open, drawing the line E O ſo, that it be equall to E D, and that the angle O, E, D, be 20 degrees, ſo that the curtaine Q. P. comes not too farre into the figure, and that the line of defenſe E R, maye come a part of it out thereof, if it be poſſible, as here to R: for the more the ſaid line commeth out of the curtaine, it is ſo much the better, which is, when the angle O, E, D, is broad and open. But this exemple if this had bene obſerved

the

the Bulwarke L, had bene a great distance from the curtaine C, D, and would haue made it much longer then it is at this present ; Then vpon the point O, shalbe made the second face of the Bulwarke, W, O, V, & so made that O, W, and O, V, and E S, are of an equall greatnes, & that the line D, X, be drawne in such a manner, that the angle Y, Z, 5, be capable to receiue the Bulwark of an *Exagone*, and for the better attayning to such a structure, ye shall make first vpon the line C, B, the flanke noted by 4, 5, and the face Z, 5, to the end that C B maye serue for a curtaine, and so fitted, that it maye almost be equall to the curtaine D. C. Then vpon C B, ye shall make the Bulwarke I. according to the greatnesse of 4, B. answerable to the Bulwarks G. H. and seing the angles A & B are sharpe : ye shall make these two Demy-Bulwarks, according to our method mentioned in the 18 Plate and so ye haue finished the thing required.

Note.

AS we haue fortified this figure on the inside : so ye maye doe the like on the outside in case the ground will afford it, but we suppose here, that it would be necessaire to make it in such a sort : in regard that the lengths of the sides require more the interiour fortification, then the exteriour; whence appeareth, that there are many vvayes to fortifie places irregular, yea, an infinite number, yet bounded with these limits, to wit, that the angles of the Bulwarks ought not to be noe further assunder then 80 rod, at least 60. that the angles flanked must not be lesse then 60. degrees. That your line of defense ought not to exceede much aboue 60 rod for by how much the Bulwarkes haue a second flanke, by so much they are the better; & the more spacious and larger the flanks and gorges are, the Bulwarks are the better for them, according to our former *maximes* set downe in the end of the first part, according to which an expert and skillfull Ingenier, will be sure as much as possibly maye be, to haue all these advantages abouesaid. And for the better facilitating of what is said aboue, wee haue made here the figures 97, 98, 99, 100, 101, which must be cutt out vpon a pastboord & drawne out vpon the same measure, as the plott of the place requireth which is to be fortified, and to fitt them to the places of the figure, with the greater consideration that possible maye bee, that he maye follow the rules abouesaid as neere as may be, where vnto these figures (in my opinion) are of very great vse : for he may turne, and remoue them on what side soeuer he will, and after he hath found the most convenient place then he maye joyne & fasten them together with a litle waxe, that afterwards he maye overcast the advantages, and disadvantages, which he is to expect.

How to fortifie an Irregular place lying vpon the side of a river.

The 22. Plate & 102. Figure.

LEt the forme irregular, which ye would haue, be the plate of *Harderwijck*, noted by the numbers 1, 2, 3, 4, 5, 6, 7, 8, whereof the extremities (or vtmost ends) are 1 & 6. touching the Dike A, B, and C, D, which ye desire to fortifie. To doe this ye must first overweigh, how many bulwarks the circuit, of the same place will take vp, husbanding them so, that ye must make as few as maye be, because they are parts of a fortification, which will cost much, and yet so, that you must not place them so farre assunder, but that the one bulwark must helpe to defend the other : for this reason we haue made the line of defense about 60. rod,

which is a longer distance then is giuen when one is to defend them with the Muskett, or caliver. The others that must be defended with the Canõ, maye be 1000 foot distant one from an other, or there abouts : becauſe at the leaſt, it will carry ſo farr over, that oftentimes a Canon will carry much further then to the vtmoſt end of the line of defenſe; ſo that they may hinder the batteries, which are made to beate downe the flank of the angle : from whence the line of defenſe is drawne, alſo ye make it ſo that the diſtance of the ſaid angle vnto the angle of the Bulwark be not ſo farre as a Canon beares, but rather ſhorter : for which reaſon we haue made it 1000, or a 1200 foote at the moſt. Now experience hath taught vs, of what litle vſe ſuch a defenſe is, ſeing a Canon cannot be vſed with that agility as a muſket, and for ſome other inconveniences, which happens to ordinance, when they ſhoote from aboue downeward. It is in noe wiſe adviſable, to make the Bulwarks ſo farre from one an other, and it were better to encreaſe the charge, then to lett them be ſo farre aſſunder. For to pretend that when the ſaid Bulwarks lye ſo farr diſtant, one from an other one hindreth the ſpoyling of the Flanks, me thinks this reaſon is too weake to take place, ſeing the continuall defenſe made with muſkettiers hinders much more Beſiegers deſſignes then that which is made by Canon ſhott, becauſe that in the interim, while they are a chargeing and makeing readie, the Beſiegers may advance much, and at laſt gett into the moate, the bottome whereof being filled with fagotts and earth caſt into it, makes the way acceſſible, and being ones gott ouer, they come preſently to make a mine in the bulwarke &, to blow it vp: but if the Beſieged haue good ſtore of ordinance ſo that they may play continually vpon them ; then it will foreſlow, and hinder them much. But if theſe places be ſo built before, that ſtore of Canon cannot be planted vpon them & that it is vncertaine, vvhither the time, the lord of the tovvne, and other accidents vvill permit, to furniſh them with ſo many ordinance, and other neceſſaries belonging to Bulwarks: vvhich if they vvere, yet the charge of the ſaid peeces vvould at laſt grow ſo exceſſiue, that the benefit which one receiue by it, would finally come to nothing : if the Beſiegers ſhould take in that place, conſidering the loſſe of their ordinance, would often times be of a greater value, then the place it ſelfe; ſo that this neede not be obſerued; but in caſes of great neceſſitie, and where it concernes the conſervation, or the ruine of a kingdome, or a countrie, and that ye are ſure to be aſſaulted by a mighty ennemy : which muſt be beaten off and reſiſted with an number of ordinance, muſkettiers, and ſmall ſhott, as the Great *Sultan*, who commonly comes into the field with two or three hundred thouſand men caring not much for the loſſe of the liues of this men, in ſuch ſort that the ſpace, which is betweene two Bulwarks, maye be eaſier taken in, when it is ſmall, then being great, for the more the ſaid Bulwarks are diſtant one from an other, the more men ye muſt haue to man the ſpace vvhich is betwixt them, which would be a disadvantage to the Beſiegers : But on the other ſide, theſe Bulwarks ought not to be ſo farre aſſunder, but that the one maye defend the other, and in ſuch a caſe I find it fitting that there be made two, or three *Caſemates* in the flanks, vvhich ye may when as the curtaines are ſo longe, that they may be made there great and wide enough, to haue the more places of defenſe which cannot be ſo ſoone ruinated by a large ſpace, as by a ſmall.

According then to theſe conſiderations, let vs come now to the fortification of ſuch a place irregular, ſituated (as we haue ſaid aboue) vpon the edge of a riuer, and obſerue, that commonly ſuch places are more longe, then broade, or deepe : becauſe the greateſt part of the Inhabitants ſeeke to haue the accommodation of the river, and as ordinarily townes are made after a good part of the houſes are built,

built, by the water ſide, whence it appeareth manifeſtly, that ſuch townes are alwaies more long, then large. Which is the reaſon that the ſides 1, 2, 3, 4, 5. 6. are more difficult to be fortified, then the others parts thereof, ſeing the angles 2. & 5 are much leſſe, then the others, as ye maye conceiue by this preſent plott, and when ye will not goe farre out of the circuit: It is wholly neceſſarie, that about the angle 5. ye make a bulwark which being pointed, the angle of the Bulvvark muſt be ſo likewiſe, as appeareth by the angles of the Bulwarck D, & I. whereof the faces are about 20 rod, and the flanks 8 rod, accommodating them ſoe, that aſmuch as poſſibly maye be the face, or the ſkirt of them, as O, P, or Q, R, looks directly towards the dike C, D, to the end, that the ſaid face may haue the more force againſt the ſaid dike CD: the like is to be vnderſtood alſo of the Bulwark A, or E: the other Bulwarks ſhalbe made as the exigencie of the cauſe requireth, as is here noted by the Bulwarks B, C, D, and F, G, H, I, whereof in all this circuit ye finde not one Bulwarke leſſe then the other; But as on the one ſide the charge is ſomewhat leſſe, ſo on the other ſide the Bulwarks are ſo farre diſtant one from an other, that the defenſe, which is made from the one bulwark to the other, either with muſket, or calliver, wilbe almoſt in vaine: in ſuch ſort, that the diſcommodity, vvhich one ſhall reape on the one ſide, wilbe much greater, then the huſbanding of it ſo as to ſaue the fortification of an other Bulwarke: Therefore the beſt way is to make one Bulwarck more, then to depriue it of its beſt defenſe, vvhich maye be made from the flanks, and ſo we maye ſay, that the fortification which is accommodated vpon the ſaid irregular place, marked with E, F, G, H, & I. is better, then that which is marked with the letters A, B, C, D, becauſe that the lines of defenſe in this are much more greater: for which one ought to take diligent adviſe that he giues himſelfe noe disadvantage, for an Ennemy vvho vvill employ all his knowledge & induſtrie thereto vvill giue him enough to doe, ſo that he needs not giue himſelfe any: in ſuch ſorte, that this obſervation is abſolutely neceſſarie. The Bulvvarks then ought to be ſo large and capable, as that they maye lodge vvithin them a ſufficient number of Muſkettiers, to defend the ſpace, betvveene the tvvo Bulwarks. For if the ſaid Bulwarks be too farre aſſunder, ye muſt then defend a large ſpace with as many men, as you would doe a litle, which notwithſtanding is againſt the order of defenſe; whereby it appeareth, how requiſite it is to obſerue therein a good proportion, to the end, that the expence, time, and labour maye be anſwerable to the benefit and profit which one ought to receiue from it. Moreover the ſaid Bulwarke ought to be made ſo large, that they maye the better reſiſt (with a body of pikes and muſkettiers lodged in the ſaid Bulwark) at that time, when as an Ennemie ſhall giue an Aſſault vpon it, and ſeeks to take it in, and by that meanes ſuch Bulwarks maye be better cutt off, then thoſe that are ſmall, as wee ſhall diſcourſe more at large hereafter when wee come to treate of *cuttingh off*: as well in generall as in particular, and ſo reſerue this diſcourſe to its due place; to the end, wee maye ſpeake more particularly of the fortification of this place irregular, which I rather chooſe (to make the Bulwark, I, the ſtronger) that the ſide of the *Polygone* were drawne towards the point C. for the preventing of the ſmalneſſe of the angle, 5. which cauſeth the ſmallneſſe of the angles P & R. for without all queſtion it is better to draw the ſaid line, then to leaue the plate, as it is at this preſent, to the intent, the inconveniency aboueſaid maye be avoyded; but ere ye doe this, ye muſt conſider, if the line ſo drawne, be capable to defend well the face of the Bulwarke Q. R. which then would fall back almoſt vpon the angle, 5. ſo that one might thereby gaine a Bulwark, and the defenſe would be much better then before: for otherwiſe, it were better that the Bulwark ſhould remaine,

as

as litle as it is, then to make it large , and open without defence. Moreouer if the Dike C, D, haue any paſſable way without it towards the riuer ſide, it vvere dangerous to make the ſaid rampart againſt it , and much better to leaue the vvall 5, 6, as it was, and to make the fortification according to this draught, then to make it as is abouesa:d: vnleſſe ye intend to take away the dike, and in ſtead thereof make a ſufficient wall to reſiſt the vvater, as the vvall S, T, extending the ſame from T to D. But ſeing experience hath ſhowne, vvhat danger there is to take avvay an ancient, ſolid, and a ſetled dike, almoſt grovvne permanent , to build in the place thereof a heape of ſtones or bricks of ſufficient ſtrenght to ſtop the violence of the vvater, one ought to conſider maturely, vvhither it vvere not better to fortifie the plaine, vvhich is here our queſtion , according to our former rules, then to hazard the drovvning of all the Counttie, to the diſhonour of the Ingenier, vvho gaue his ad-viſe for ſuch a change, to the dammage and hurt of the Inhabitants , asvvel of the tovvne it ſelfe as of the countrie, yea, by endangering the ſubverſion of many hou-ſes, villages, together vvith the ruine of man and beaſt. Which an Ingenier of a ſound judgment ought wel to conſider & not lightly giue conſent to ſuch an alteration, vnleſſe it be in a caſe of extremity, or elſe in conſideration of a very great advantage, vvhich one might receiue thereby.

If the vvall S T be much raiſed, as it often hapneth there vvere the countrie lies lowe, and the rivers flovve high, that one cannot well defend from the curtaine the face R. It were good to make the Bulwarck H, Y, Z which is 9. & 10. 11. A, and the Demy V, X, θ, which would leſſen ſomewhat the circuit of the towne; but would hinder much the former inconveniency, and the charge would be leſſer : for as then there would be but foure Bulwarcks, vvhich vvould haue the lines of defenſe capable, and able to defend the ſame Bulwarks, and ſo the Bulwark O, P, or Q. R, would not come ſo neere the Dike C, D, which being wholly commaunded by the ſaid Dike, the force vvilbe leſſer : for the ſmall diſtance betvveene Q, and C, or from T, to R, vvould cauſe the Beſiegers to make that Bulwarke continually in-effectuall , as vvell by Canon as Muſkets, as by caſting in of fireyvorks into it, vvhich could not be done , if this bulvvark ſtood backvvard as here H, Y, & Z doe, and yet is neere enough to defend well the face X, 6, as alſo the moate: euen as this forme demonſtrateth , marked vvith the double blinde lines , 12, 9, 10, 11, A.

That vvhich we haue ſpoken of the ſide 5. 6 maye be ſaid alſo of the ſide 1, 2. But if the defenſe of the Bulvvarck E, be better then of the Bulvvark F, reaſon requi-reth, that it be left ſo , vvithout altering the ſaid Bulvvark E; by takeing diligent heede, of the advantages, and diſadvantages , vvhich the ſite of the place maye bring to ſuch accidents as may fall out, according to vvhich ye muſt order & accō-modate the Bulvvark : for moſt often the ſeate is that part, vvhich ought moſt of all to be had in conſideration, not onely in this figure , but alſo in all others vvhat-ſoeuer they bee, either regular, or irregular.

Note.

THat in maritimate places, ſuch as are ſituated by a riuer ſide, where the banks, or dikes, come to touch , ye muſt drawe them in ſuch a manner that the ſkirt S, 6. maye be as farre diſtant as poſſibly maye be from the extremity, or vtmoſt end 6, that the ſaid ſpace S. 6, maye help to defend the furtheſt part of the ſaid Dike. D, C.

How

How to fortifie a place ſituated by a river ſide, where it is neceſſarie to make alſo ſome fortification on the other ſide of the water oppoſite to it.

The 23. Plate, & 103. Figure.

LEt the tovvne irregular be A, B, C, D, E, F, G, & H, having many other oblique cornes, as well interiour as exteriour, ſituated vpon the ſide of a large river, about ſome 200, or 300, foote broad & that the ſide M, N, of te ſaid towne (as it is ordinary) is in noe vviſe fortified; vvhich place you are deſirous to make ſtronge, and capable of reſiſtance. To doe this ye muſt firſt dravve the lines F E, D B. ſo that they fall not into the old moate, but that there be left ſpace enough to make a rampart therevpon, on the outſide vvhereof ye ſhall trace out your Bulvvarks, according to our precedent rules: ſo that the lines of defenſe doe not much exceede aboue 60 rod, vvhich is within a muſket ſhott (as vve haue often times ſaid) to the end, that the one Bulvvarke maye helpe to defend the other, as the art of defenſe requireth, vvithout makeing many angles, or ſides, as much as poſſibly may bee, to ſaue charges: becauſe it is certaine, that the Bulvvarks, vvhich are made vpon a right curtaine, are ſtronger then thoſe that are made vpon angles: for ſeing (as vvee haue ſaid at the firſt) that the figures of many ſides are better to be fortified, then thoſe vvhich haue fevver: for as the quantity of the ſides diminiſh, ſo alſo the greatneſſe of their angles diminiſh, vvhich aftervvard cauſe the greatneſſe of the angles of the *tenailles*, or Flankers: and the more the ſame angle flanking is open, the leſſe is it capable of flanking; contrarievviſe, the more the ſaid angle of the *tenaille* is pointed, it hath alvvaies bene found the better: ſo that this is without all diſpute. According to vvhich; ſeing that the greatneſſe of the angle of the *Polygone* begetteth the ſmallneſſe of the angle flanking, & that the, more open the angle is the neerer it comes to a 180. degrees (vvhich make tvvo right angles) it is manifeſt then, that Bulvvarks made vpon tvvo right angles (makeing a continued line) are better, then thoſe vvhich are made vpon ſome angle leſſer then the tvvo right angles are, and hereby vvee haue ſufficiently proued the goodneſſe of thoſe Bulwarks, vvhich are made vpon right lines, which is the cauſe (as I beleeue) that a great Mathematician conſumed his time wholly in this point, by maintayning that all fortifications, aſwell great as ſmall ought to be made in a ſquare-forme: but ſeing that the Bulwarks towards the 4 angles by this meanes become leſſe forcible then the others, as the figures A and B, demonſtrate in the 23, Plate: me thinks, this ought to be taken into conſideration. Whither it were not better, to make a Fortreſſe, whereof the Bulwarks and the lines of defenſe be of a like force, then to make them as aboue. For it is impoſſible, that one ſhould make a fortreſſe ſtronger in one place, but ye muſt diminiſh the ſtrength thereof in an other place, to wit, as the common proverb is, one ought to cutt his coate according to his cloath; But when the ſituation of the place, and the *avenues* thereof be ſuch, that one maye be aſsured of the reſiſtance, which maye be made better here then there, reaſon then requireth that in ſuch a caſe, one muſt make ſuch an *avenue* ſtronger, by diminiſhing the ſtrenght of an other, which is not ſo ſubject to be attempted as the former is: For the ſite of a place ſometimes will require this irregularity. But when as it falls out in a plaine field, it is reaſon that the ſtrength thereof be alſo regular, ſo then in ſuch a caſe one cannot take any advantage in one place more then an other, without hurting, and weakning of an other, which one ought maturely to

 conſider,

conſider,and not yeeld eaſely therevnto vvithout good and pregnant reaſons. And ſeing theſe Countries,which lye lowe,and are ſubject to invndations & overflowings,the rivers are commonly bounded in vvith Banks and Dikes,for the preventing of ſuch inconveniencies and the preſervation of the Inhabitants from an vtter ſubverſion. Theſe dikes coming to touch both the one and the other part of the ſaid tovvnes (as here in the points H,& A.) vvhich ſometimes are ſeparated from the ſaid towne by a vvall,vvhich goes from A, to N. and from M, to H, vvhich in the Figure C is called a *Doudan* made in the forme of an Aſſes back,narrow in the midſt , and bending downwards on both ſides,vvhich is made ouer a moate (to ſtop the vvater,vvhich other vviſe vvould breake into the land) is called by thoſe of theſe countries a *Beer* that is, a Beare; in regard of the ſtrength, vvhich makes it almoſt inviolable. Therefore the *Baſis* , or foundation of ſuch a worke,is layd firſt with a grate of beames of timber, locked one into an other with ſquared beames bound faſt together; vpon vvhich the vvall is built : theſe beames and piles vvhich are driuen in and layd in this groundvvorke are ſome 8, 10, or 12, foote long: according to the depth of the riuer; and about 7, 8, 9, or 10, ynches thick,lying tvvo or three foote diſtance one from an other , vvhich alſo ought to be in length anſwerable to the depth of the vvater. Sometimes theſe *Beares* are made vvholly of timber,and are lyned vvith huge thick oaken plancks, betvveene them cloſſe together, and are much longer then the former ; becauſe the vpper ends muſt ſtand ſo much aboue the vvater, as ye thinke the vvater can riſe in winter,and on both ſides of theſe piles , you ſhall laye tvvo great beames or bands of timber,the one at the endes of the piles,and the other in the midſt, betvveene the bottome,and the vpper end of them,faſtned together vvith yron bolts (vvhich are as thick as theſe piles) and paſſing through theſe piles , and then ye ſhall line them with good ſtronge oaken boords,in joyning them as cloſſe together as poſſible maye bee,that they maye keepe out the water the better , and laſt the longer. Now if ye reſolue to make noe ſuch ſeparation, but to let the banck or dike ſtand, then it wilbe good to cutt and pare it as narrow as you can , to keepe an Ennemy from coming vpō it with many men in front,or to hinder his approches the better on that ſide. I am of the opinion alſo,that ye ought to make the line C, B. & F, G. about 300 , foote longe, that one might giue the more fire vpon an Ennemy, both at his falling on,and going off ; but when there is noe fortification made on the other ſide of the riuer,it were much better that the dike did not ſtand againſt the point A ; but that it were made neerer to the inſide of the towne , that one might the better offend the approches made on the outſide thereof,to wit , towards the river,as is ſhowne in the former Figure and 22 Plate : but if the other ſide of the riner lying oppoſite to the towne,ought to be fortified,(for the reaſons abouesaid) then it matters not greatly : ſeing one maye ſufficiently offend the Approches on that ſide : and becauſe the cutting off would be chargeable,if it be made in a *circular forme* (me thinks) the beſt courſe is to draw the right line, O,P and the two others O,Y, and P. K: ſo that O Y, and P. K. maye be of the length of one of the ſides of an *Octogone*,or thereabouts,that the Bulwarks , O & P. maye be well defended from the curtaines , and that the Bulwarke alſo on the other ſide, maye likewiſe helpe to defend the curtaines:then betweene O and P. according to their diſtance maye be made the Bulwarks Q. and R,but ſeing the diſtances E, F. and B,D. are too longe to be defended from the Bulwarks D, &, E. ye muſt make the two Bulwarks S, T. whereof the faces are 16 rod,the flanks 8 rod , & the faces of the other Bulwarks are each of them 20 rod,or thereabouts:which diſtance is capable to lodge men enough in it , to defend it,and if neede requires, to make

alſo

alſo therein ſome ſpeciall cuttings off, as wee ſhall declare vnto you hereafter.

Note that if the lines D, B, F, & E, be too ſhort to make the Bulwarks vpon them, marked S, & T: it is apparant ye maye then lengthen the ſides ſo farre, that the ſaid Bulwarks maye (with conveniency) be made vpon them, then ye muſt drawe a line paralell to D, E. but if the diſtance D, B. and E, F. be ſo, that the angles B & F maye be defended well from the Bulwarks E and D. as then you neede not make the ſaid Bulwarks S. and T: ſeing that from the others, namely, E & D, they maye be ſufficiently defended. And for aſmuch as I finde theſe fortifications to be beſt, which come neereſt to the demenſions giuen before in our regular fortifications, termed *Royall*, whereof the faces, flankes, defences, and gorges (which are the principall parts of a fortification) are all capable to worke well their effects: one ought to haue a ſpeciall care aboue all things, to fitt the ſides of places to be fortified, that they maye be almoſt of the length of *Polygones*, which ye ſhall finde in the table of our demenſions, deſcribed hereafter, euen as wee haue done here in lengthning the ſides B, D, and F, E. till that X, Z be equall to the lengthened ſides B, X. and F, Z. Vpon which, and in the very midſt of them, ye ſhall make three Bulwarks and vpon the angles X, and Z, the two Bulwarks X, and Z, which are the Bulwarks of an *Hexagone*, becauſe the angels X, and Z, make each of them 120 degrees, which are (indeed) the angles of an *Hexagone* as appeareth by the ſaid table, in which are taken all the demenſions belonging to an *Hexagone*, aſwell the gorges, flanks, as the faces: and from them, ye maye drawe out your Bulwarkes X and Z, aboueſaid, which wilbe more *royall*, then the two Bulwarks D, and E, yea or of the others likewiſe: ſo that this fortification will not coſt much more then the former, makeing the place more ſpacious, the circuit almoſt alike, and the Bulwarks much better: and in my opinion, this forme of fortification ought to be preferred farre aboue the other, conſidering what advantages one maye gett thereby. But if one were tyed to the forme B, D, E, F, whereof the two ſides B, D. and F, E, are longer then 90 rod, which is a diſtance too farre for the Bulwarks D, & E. to help to defend the angles F and B, one ſhould be driuen to make the two Bulwarks S. T. leſſer then the former, whereof the faces would make but 16, rod, which notwithſtanding wilbe capable to defend the aboueſaid Angles F, and B.

Note that if the place requires, that ye muſt lengthen the line O, P. as farr as the riuer ſide I, K. lyeth, then ye maye drawe from the furtheſt end of the Bulwarks O, and P. right lines to I, and K, and then ye maye make two Bulwarks vpon the ſaid lines, one vpon the right curtaine, by which ye ſhall make your fortification the ſtronger, becauſe the angles of the Bulwarks O, P. wilbe ſo much the larger, and the defenſe of the other Bulwarks vpon the ſaid lines the better.

How to fortifie a place ſituated by the ſea-ſide, and to make therevnto a commodious Haven.

The 23 & 24. Plates, and the 103. & 104. Figures.

PLaces lying by the ſea-ſide, haue oftentimes neede of a good hauen, aſwell to harbour ſuch ſhipping, as maye daylie come into them, as alſo to keepe them ſafe from an Ennemy, and from the violence of ſtormes and tempeſts: And for aſmuch as theſe places muſt reſiſt the injuries of winde, weather, and the raging billowes of the ſea, as is ſaid, they ought to be ſoundly fortified and kept: and becauſe Earth alone will not be ſufficient to withſtand the beating of the ſea vpon them in regard of the fragility thereof, which would be waſhed away, ſuch places

ought to be made with *free-ſtone*, or at leaſt wiſe with good brick, with driving in on the outſide of the wall next the ſea-ſide many ſtronge piles, by claſping them together in this manner following:

FIrſt ſome 300. foote, or thereabouts from the wall A, B. (marked figure 104) ye muſt driue in a rowe of piles a foote thick in *diameter*, and ſome 8. or 10. foote longe, as the 24, Plate, and the 104, & 105, Figures demonſtrate. Theſe muſt be pointed with yron, and ſharpned well, that they maye enter the better into the ground, and muſt be driuen in with an Engine called in Dutch a *Hye*, hauing a block plated with yron of ſome 1000, or 1200; pound weight, which falls downe vpon the heads of theſe piles, and is drawne vp with a pullie, with ſome 40. men, euen as one ſhould ring at a Bell, foure or fiue of them guiding the *Hye*, that the logg maye fall downe perpendicular juſt vpon the head of the pile, that they driue in, and ſhall driue it in ſo deepe, till the head thereof be but three, or foure foote aboue the ground.

After ye haue driuen in the firſt row, ſome ſixe or ſeuen foote diſtance from it, ye muſt driue in the ſecond rovv, whereof the vpper ends muſt be aboue the ground, more then the firſt row by a foote and a halfe, or at the moſt two foote: ſo that your ſecond row ought to be foure foote and a half, or at the moſt ſixe foote. Then about ſixe foote neerer the towne, ye muſt driue in a third row of piles, the heads being a foote or two foote aboue the ſecond row, as the ſite and the neceſſity of the place ſhall require, continuing ſo till you come to the very wall of the towne againſt which you ſhall laye bedds made of Bundles of bruſh (as the figures 106. and 107. ſhowes) wherevpon ye ſhall lay heauie ſtones 3, or 4, *cubicall* foote thick, to make them lye firme and faſt betweene the rowes, which are alſo driven in with ſtakes, or ſparrs as the figure 105, & 106, demonſtrate. All theſe rowes muſt be ſo ordered by a maſons line, that they may lye euen from the one ſide to the other, and to keepe them cloſſe together, ye muſt haue long ſparrs ſawne in two, through which you muſt boore holes, and driue yron, or wooden pinnes through the ſaid rowes, and clinch them well, and (as is ſaid) remember, that the piles of the ſecond row are longer then the firſt, and the third rovv longer then the ſecond, and ſo conſequently the reſt muſt bee. Then euery ninth foote, ye muſt laye croſſe ſparrs of the ſame weight as the firſt, or thereabouts, which ye joyne to euery row by driving great yron bolts through the piles and the other ſparrs, vvhich lye croſſe the other rowes, makeing through them *quadrangular chambers*, vvhich you lay bundles of bruſh into in makeing them lye faſt together by diving in of ſtakes and in laying firſt a bedd of bruſh, and then a row of flint ſtones vpon it, and your bruſh muſt be hedged, and wreathed together, to make it lye the faſter and firmer, that it maye not be looſened, and driven away, with the violence of the vvater, as ye maye ſee in the 24. Plate, and the 106. & 107. Figures.

This being done, then ye ſhall laye the *Baſis* of the wall firſt by driving in piles into the Earth and foundation, if it be mooriſh, as the 108. figure ſheweth: But if your foundation be good and firme, then ye ſhall make (as it were) but a *Gridiron* of wood vpon it, as the figure 109 noteth, theſe ſparrs vvherewith you make it, muſt be ſome 8, 10, or 12, foote longe (according to the ponderoſity of the wall, and as your foundation ſhall require) and ſome 10, or 12, ynches thick. Vpon this you ſhall beginn to lay your wall about 10, or 12, foote thick, allowing to euery foote of *talude*, two foote of height, laying within it ſpurrs of wood from 16, to 20, foote, and foure or fiue foote longe, making them lye levell with the wall (as the art of *Maſonrie* teacheth) and ſome ſixe foote diſtant one from an other: then by this meanes, ye

ſhall

ſhall binde the vaults one to an other, and the two vaults ſhalbe comprehended by the third, to make them laſt the longer, and wilbe the better able to reſiſt the waues of the ſea, when the winde makes them beate againſt the vvall , filling the vaults, vvhich are betvveene the ſpurrs vvith good Earth, ſtamped and beaten in wel, that there be noe holes, or hollovvneſſe betvveene them : In doeing ſo ye make your hauen as the greatneſſe of the place vvill beare it, and according to the number of ſhips, vvhich you meane to harbour in it. The mouth or entrance into the hauen being ſome 20, 24, or 30, foote broade, according to the greatneſſe or ſmallneſſe of the ſhips that are to come into it. Ye maye make the hauen , either of a round forme, ovall, ſquare, or (a *paralellogramma*) vvith a right angle, as the ſite of the place and the accommodation of the Inhabitants ſhall require. On the outſide of the mouth, ye ſhall driue in the breath of 100, or 150. foote rovves of piles, from one end to the other, as abouesaid, which maye ſerue for the comming in, and going out, to make the entrance of the ſhips the more eaſie, as appeareth by the 104, figure : in vvhich the paralell lines A B, C E, E F, F G, G H, H R, are rovves of piles filled and ſtuffed vvith bundles of bruſh, and ſtones vpon them , as vvee haue noted in the 106. figure, where ye muſt obſerue, that the vvall of the figure 106, vvhich ye ſee on the outſide , is the ſame as the figure 110 is, vvhich ye ſee on the inſide. The reſt of the tovvne, aſvvell that part of it vvhich lies next the ſea , as the other ſide maye be fortified in that forme as the plate of *Oſtend* demonſtrates , vvhich is the next followving, makeing your fortification ſoe , that the faces of the Bulvvarks maye be about 100 foote or more, to hinder the better the approches , vvhich an Ennemie maye make on that ſide, ſeing thoſe places wilbe the weakeſt, in regard of the banks, and ſhelues of ſand noted Z, which are commonly in ſuch places: Therefore one is conſtrained to raiſe the ramparts higher in ſuch places , then the order of fortifying vvel requireth, that one maye lye the ſafer vnder couvert from an ennemies batterie. If the vtmoſt ends A, and B, be of a rock, ye muſt cutt them off as much as poſſible maye be, both in the height, and in the bredth, as the commodiouſneſſe and the ſite of the place vvill afford : if it be ſandie it vvilbe ſafer to deepen the moate euen vp to ones neck, in caſe the countrie circumjacent vvil permit it, as ye maye ſee here in the 25. Plate of Oſtend & the Figure 112, in vvhich towne hath bin practized & found out as many inventions to make it invincible as in any tovvne of our age, and noe leſſe inventions tryed on the ennemies part to gaine it, vvhich they did at laſt after three yeares , three months and odd daies ſiege, vſing all manner of induſtrie, in makeing their the approches, galleries, mines, and other inventions, which the art of man could invent them. Neither was there leſſe art vſed on the defenſiue part to make them get it by ynches meale as appeared by the generall, and particular cuttings off, counter mines , counter-batteries, and other vvorkes vvhich vvere made in ſuch ſort, that this place vvas as it vvere a ſchoole, and a ſtuddie of euells, to bring men to thier ends , vvhere nothing vvas either omitted, or forgotten , but many ſtrange engines invented, aſwell to ſtop the mouths of the channels and hauens, as for the approches towards the tovvne, as this 25. Plate demonſtrateth , where ye ſhall ſee the approches made with gabions, or great Baſketts filled with Earth & woolſacks to ſtop the water breaches and at other times ſand-baggs: for the reaſon why they made vſe rather of theſe things, then to advance their workes and by approches & ſapps (whereof we intend to treate hereafter) was becauſe the countrie lay low, and was ſometimes overflowne with water, in regard of the ebbing and flowing of the ſea, entring in, and going out betweene the mouths A & B.

Of ſome looſe Peeces in regular fortreſſes.

The 23. Plate & 111. Figure.

MAny men are of the opinion, that in places of great importance to forſlow and hinder an ennemy the more, one ought on the outſide of a place regular to make diverſe works ſeparated from the bodie of it, by that meanes to giue the Aſſaillant the more worke, that he cannot come to advance his deſſigne. And though I dare not approue much of them; in regard of the great expence which they will coſt, and the number of men neceſſary to keepe and defend them: yet I will giue here ſome inſtruction to thoſe, that are deſirous to make ſuch works. Let A B then be the ſide of a *Decagone*, vpon which ye ſhall make by the helpe of our former table the Bulwarks Q, T, Y, Z, S, R, then ye ſhall drawe the paralell lines G, I, H, and H P, for the faces of the Bulwarks of the diſtance of ſome 10, or 12, rod, for the bredth of the moate, and for to finde the angle L, M, N, ye ſhall draw the angle of the ſhoulder paſſing through the angle of the Bulwarke R. the line R M, the like ye ſhall doe vvith the line Q, M, then ye ſhall make the faces L M, M N, of 24 rod, from whence ye ſhall dravv the flanks L K, & N O, equall to the flanks T Y, or S Z, and finally the lines I K, & O P, anſvvering to the points Q, and R. & for the better keeping of them ye ſhall make the Ravelins V W X, vvhereof the angle W comes noe further from the center of the fortreſſe then the angle M, dravving from the angle of the flanke O, a line vnto the point W, and the face V, W, of the length M N. Ye maye make likewiſe the flanks 3, 4, & V 6, but then the defenſes of the Bulvvarks vvilbe of noe vſe, becauſe they blinde the faces L M, & M N, on the outſide of theſe looſe vvorks, ye maye make a good moate vvith a couvert vvay, and a parapet, as the figure 111 demonſtrateth. Theſe vvorks vvill coſt much, and ye muſt haue a great many men to guard them: ſo that one ought to be vvell adviſed ere he vndertakes the makeing of them: and to ſee if the meanes of the Lord of the place, his forces, and time will permitt it: more ouer he ought to conſider that the entrances in and commings out of the ſaid looſe peeces, are dangerous and difficult, and therefore hardly to be relieued.

How to make a fortreſſe, where two great riuers are not aboue 15, or 18, rod aſſunder one from an other, or thereabouts.

The 26. Plate & 113. Figure.

THat you maye the better vnderſtand my intention and meaning I haue thought good to make vſe of the Plate of S. Andrews Fort made by the *Admirant of Arragon*, that yeare as he withdrew his army from the ſiege of *Bommel*, which is a Fort ſituated in *Bommelsvvard*, betweene theſe two great rivers called the *Maſe*, and the *VVhale*, haueing noe great diſtance betweene A & C, then ſome 80, rod, being the narrovvſt place of the whole Iland, and conſequently ſtronge by nature and ſituation, having but two *avenues*, or paſſages to come to it, to wit, one vpon the left ſide from *Roſſems* field, and the other on the right ſide from *Hervverden* ſituated at the vtmoſt end of *Bommelsvvard*, oppoſite againſt the *Vorne*, or *Naſſaus Fort*, which is a fortreſſe, with fiue Bulwarks, and well made. Now to ordaine the ſaid place, ye muſt firſt reſolue if ye intend to make a Covert-Way vvith a parapet

parapet round about the place, and with all ſuppoſe that the circuit interiour (though litle enough) is able to lodge in it as many men, as ye meane to leaue there in garniſon, according to which ye ſhall firſt make the angles of the *Tenailles* A,B,C, and according to the courſe of the ſides of both the rivers ye ſhall make the tvvo angles of the Tenailles A,I,H,& C,R,D, and finally the other two D,E,F,& F,G,H, &c. which angles, becauſe the ſides of the rivers runs ſomewhat ſlanting towards one of the ſides, they cannot be equall, which cauſeth the inequality of the ſides of the Tenailles, and conſequently of this fortreſſe *Pentagonall*: then ye ſhall make of the diſtance of ſome 6, or 7 rod, paralell lines to the lines A,B,C,R,D, which vvill forme the bredth of the parapet for the covert way: then on the inſide ye ſhall make a paralell of ſome 18 foote for the bredth of the covert way, the bredth of the moate about ſome 7 rod, which lines of the moate towards the interiour ſide, make the angles M,N,O,P,Q, which ſhalbe the angles of the Bulwarks, the faces, flanks, and curtaines whereof often ye ſhall finde rules giuen in our former rules of the 10 Plate, and ſo ye ſhall haue the thing required. The Heads K, and L, are made to breake the courſe of the water, which otherwiſe would ſpoile the fortification and eſpecially the angles D,& H, of the parapet of the covert vvay, vvhich having a good moate of ſome 12 rod, as this Plate ſheweth, it wil make a great reſiſtance.

Note.

THat this figure for want of takeing heede, is turnd the wrong way: ſo that the angle F ought to be with all that which lies on that ſide on the left hand; and the angles A,B,C, with all that is on the left hand towards the right hand, the cauſe is, becauſe they cutt the Plate as the Figure was marked.

How a Generall ſhall come to beſiege a Towne.

WE haue for a time bene minded to deſcribe the order, which an Army ought to keepe in marching towards the place, which one intends to beſiege, where it is neceſſarie to treate of militarie motions, of the order of the march, vvhich every ſouldier ought to obſerue in particular, as alſo of the Companies, Regiments, and of the vvhole Army, but ſeing I haue noe leiſure to doe it at this preſent, I will reſerue that for the next Edition to make this and other things in ſome places more compleate. And now vvee vvill beginn to treate of quarters, and lodgings of euery companie, then of euery regiment, and finally of the whole army, as alſo of their entrenchments, and the things vvhich depends thereon, that we maye afterward come to the approches, ſapps, mines, galleries and interiour cuttings off, as followeth.

The 27,28, *Plates, and* 114,& 115. *Figures.*

WHen as an Armie is come within 3, or 4, miles of the place, where it ſhall quarter. The Quartermaſter Generall goes out before with ſome 50,80, or 100 horſe, that he maye the better view the ground & place where the army ſhall encampe, before they come thither, which ought (if it be poſſible) to be neere vnto ſome river ſide, nor farre from a good wood, and where there is good ſtore of forrage, aſvvell for horſe as ſtravv & wood for hutting and makeing of paillaſſes. The ſaid Quartermaſter Generall then having viewed all the grounds & choſen the beſt, ſhall drawe a draught of it, and ſhow it to the Generall of the Army, which being

being done and resolued, he shall then goe in all diligence with all the other particular Quartermasters of the Regiments, to giue them their ground and quarter: which shalbe 300 foote deepe, and the bredth according to the number of the Companies and the greatnesse of the Regiments. After this the particular Quartermasters shall line & draw out their quarters to distribute them according to the number and qualities of the companies, giuing to euery companie, which is about 110 or 120, two rowes of Hutts, to these which are 150, 3, rowes, & to 200, foure rowes, and all running downe in right lines from the front, so that the said rowes are all paralels one to another, each row being 200 foote deepe, and 8 broad The Sutlars Hutts must be 20 foote deepe, and 60, foote is allowed for the Captaines Hutt, and enbowring, and the streete betweene the Hutts, and the said lodging are 100 foote, which with the 200 foote for the souldiers Hutts, makes in all 300 foote, which is the depth, that a regiment must haue, either for Horse, or foote, & other quarters: and the rowes betweene them, which make the streets & back streets, shall be likewise & must be 8 foote: which rowes in their depth shalbe divided into 25 parts, so that euery of them make 8 foote for the depth of the said Hutts, and the bredth being likewise 8 foote, each hutt will containe 64 foote square, for euery two souldiers, that they maye the better lye together and help each other, as well in makeing vp their Hutts as before and afterward. And for the better accommodation of the Army the Quartermaster Generall ought to take care, that the Quarter (as is said) be neere vnto some river, wood, and fourrage, and to labour that the said Quarter be provided with all things necessarie, and quartred as neere the Towne besieged, as possibly maye bee, to the end the trenches and approches maye be relieued, as soone as maye be in case of necessity: And seing oftentimes there happens some mischiefe amonge the Hutts, which joyne close together, when as fire takes them, so that one row, a whole streete, yea sometimes the vvhole Quarter is burnt before any order can be taken, they shall build them 1, 2, or 3, foote asunder one from another, to the end one maye pull them downe quickly without endangering the other, and so by this meanes maye be kept from tyring. From the front of the Hutts, ye shall Kitspit 10, foote, where ye shall sett vp your crutches for your piks and armes, and beyond them some 16, or 10, foote further is the distance betweene the Captaines lodging and the armes being 28, 30, or 32, foote deepe, and 24, or 28, broad in the front. But when the streets betweene the Hutts, and the Captaines lodging are but 20 foote, then the said lodging is to be 40 foote deepe. Beyond the Captaines Hutts there is a place of 200, or 250, foote or thereabouts called the Alarm place to drawe in armes, at the end whereof the line of entrenchment for the Campe runneth, to wit, haueing a ditch some 6, 7, or 8, foote broade, 5, or 6, foote deepe, and the parapet of the same bredth and height, to wit, the basis of 8, foote, and 4, or 5, foote high: but when it is 6 foote high, then ye must make a foote banke which must be a foote high, and 2, or 3, foote broad, that ye maye the better discouver the fields about ye. Behinde the Regiment are the sutlars Hutts or tents, leaving a street betweene them and the souldiers Hutts of 20 foote and the bredth of their hutts are likewise 20, foote. Betweene the sutlars and the other Regiments there is a streete, or a separation made betweene regiment and regiment about 40, 50, yea 100, foote as the ground will afford it, and the greatnesse of the said Regiments. And the better to accommodate euery Regiment, the Quartermaster Generall ought to know the greatnesse, and the number of the companies of them. And so, as is said, ye haue the depth of a regiment, which is 300, foote, in which are contained the Captaines, and the sutlars lodgings with their streets, and the distances betweene them and the souldiers.

The

The Colonell is lodged in the midſt of his regiment leaving a ſtreete of 80 foote, as the Figures 114 & 115 demonſtrate, to lodge therein his traine and the officers of his Regiment, as the Quartermaſter, the Marſhall, Chirurgian, & others. In the midſt of the quarter the Generall of the Armie is lodged ſome 600 foote, or more from the entrenchment, according to the greatneſſe of the Campe, and the accommodation of the place, having a front of ſome 700 foote more or leſſe, as his traine is either great or ſmall, being 300 foote deepe (as all the other quarters are) having in the midſt, where they ſett his pavillions, an overture of 400 foote broad, for to diſcouver by ſight the place where they drawe vp in armes. Behinde him the maſter of the ordinance is quartered, having his quarter 300 foote deepe, and 700 foote in front more or leſſe according as his traine is great. For in caſe that the carrages and victualls muſt be lodged within the compaſſe of the Campe, it is very neceſſarie the ſaid place be larger, that it maye containe them all, and as then ye maye ſeparate the traine of victuals from the traine of the ordinance. Upon the right hand are lodged ſometimes the other Officers belonging to the armie, leaving betweene them and the reſt, a ſtreete of ſome 40, 50, or 60, foote, that they maye freely paſſe through it with the ammunition of warre, to the place where they are to be vſed: and then round about it are the foote lodged, according to the former order, being as is ſaid) 300 foote deepe with the Captaines tents, and the ſutlars hutts, and the bredth of the front according to the greatneſſe of the regiment, euery companie of 100 men takeing vp 32 foote with the ſtreets, which are betweene the hutts, and before them is the place of Armes 200, or 250 foote, to draw vp by companies into their diviſions and battallions, to wit, euery companie directly before his Captaines lodging & their to draw vp in parado & to receiue the commaunds of the Generall of the Army. In the front of the hutts the Lieutenants and Enſignes are lodged, and the Sergants & Gentlemen of the armes in the reere next the ſutlars, they maye preſently prevent any disorders which might fall out. And for the more eaſie vnderſtanding of what is ſaid aboue in the 27 Plate, & 114 Figure, wee haue here repreſented the quarter of an Engliſh Regiment conſiſting of 20 Companies, as they were quartered (as I remember) before *Gulick* whereof the Plate K, L, M, N, O, P, is the Colonels lodging, Q, R, S, T, his Kitchin & Stable, H, I, the Captaines lodgings 24 foote broad, and 30, or 32, foote deepe. G, the crutches or the forks againſt which the Pikes and Muſkets ſtand. C A, the ſouldiers Hutts, whereof euery file containeth 25, and 8 foote in depth and bredth, the goings out are betweene the two files; but the foure vtmoſt hutts of euery companie haue their goings out towards the ſtreets, C H, & A E, which is the Sutlars ſtreete, E F, are the Sutlars Hutts, which are made either large or ſtraight, as euery ones occaſion ſhall require, leaving a litle ſpace betvveene them, for their more freedome, and for the danger of fyring. The ſcale which is hereynto annexed will ſhew you the true meaſures.

The 28, Plate, and 115. Figure.

THe 28, Plate is the draught of a Colonels lodging, in a larger forme, that one may the better vnderſtant the order, which is here to be obſerued. 9, is his tent, & his galletie to goe into his tent, 5, 6, is his ſleeping tent, where it maye be ſo ordered, which would not be amiſſe, that there be a gallery from 5, to 6, to goe in and out prively from one tent to an other, 7, is a hutt for the Colonels ſervants: 11 his Kitchin, 10 & 12 are alſo Hutts, 13 is his Stable, 14 and 15 are the officers Hutts of the Regiment, and all other officers, which are not ranged vnder any Companie,

are lodged in this ſtreete, behinde the Colonell. 2, & 3, are the Captaines tents, 16, & 17, the places where they draw vp in armes, 4, 4, 4, 4. are the ſouldiers Hutts, the ſide K L, from the colonels lodging is a right line with the Captaines lodgings, not to hinder the ſight of the front of the Hutts. But as for mee I thinke it were more convenient that the front of the Captaines lodgings, were made in a right line euen with the front of the Colonell, to wit, that 2 & 3, and M, & N, maye be in a right line, whereby the alarme place ſhould be of an equall bredth.

The 29. Plate & 121. Figure.

IF neceſſitie requires to quarter the Horſe vvith the foote within the circuit of one line, which is vſually done when one feares an Ennemie to fall on vpon many ſides, and that there is noe other accommodation for the horſe without the campe, otherwiſe it were much better to lodge the Horſe out of the foote quarter, for the avoyding of many inconveniences, which the foote might receiue by them, and which the Horſemen might receiue from the foote, leaving betweene the Sutlars Hutts of the foote and them, a ſtreete of 40, 50, yea ſometimes of 100 foote according as the place will afford it, having their front towards the place of armes, & euery regiment quartred together, being commonly 8 troupes in a regiment allowing to euery hutt 10 foote in length: betweene them and their Horſe there is a ſpace, or a ſtreete giuen them of 5, or 6, foote broad, to lay in their fourrage: then betweene the ſame 5 foote, & the great ſtreetes (which are ordinarily 20 foote) is made a ſpace of 10 foote for their horſe, allowing to euery horſe 4 foote in bredth. The great ſtreets are made as is ſaid of 20 foote, the narrow of 8, or 12, foote, that they maye the better come one to an other, and to joyne together in caſe of neceſſity, and for other conſiderations, in ſuch wiſe that in one row, which is 200, foote in depth, there are three ſuch ſtreetes of 8 or 12 foote: For otherwiſe the rowes, becauſe of the great ſpaces, which ſuch Hutts will take vp, makes the entrance into them vneaſie, and thus the lodging of a troupe of horſe of 70 foote, to wit, the lodging of the Horſmen 110 foote & 2 ſmall ſtreets 5 foote, the ſtreete betweene the Horſe 20 foote, and twiſe 10 foote for their horſes, which makes in all 70 foote: and when as the ſtreets betweene the Horſe-heads and the Hutts ſhalbe ſixe foote, the front wilbe 72 foote, of which bredth the Captaines lodging is made, leaving betweene him and his ſouldiers Hutts a ſtreete of 18 or 20 foote, and the depth 40, or 42, foote, and ſeing the depth of the Horſemens Hutts is 200 foote, as the Hutts of the foote are and 40 the Captaines, with the ſtreete of 20 foote, makes 60, foote and 40 for the Sutlars ſtreete, it is manifeſt then that the quarter for the Horſe (as is ſaid) wilbe 300 foote deepe. Then betweene the companies there is a ſtreete of 20 foote, which if neceſſity requires maye be made narrower. And ſeing the Captaine which commandeth a Regiment of 4 or eight troupes, hath noe greater traine then an other horſe Captaine hath, he is lodged noe otherwiſe then they are; neither takes vp any more ground, onely the honorableſt place is giuen him, becauſe he commandeth for that time: but the army being in garniſon, hath noe commaund ouer them.

In the front of theſe Hutts are lodged the Lieutenants and Cornets, and next vnto the ſutlars ſtreete are the Hutts of the Corporals and Quartermaſter, that they maye vpon any occaſion be ready to prevent any diſorders that maye happen. Beſeides the ordinary Sutlars, which vſe to follow the Regiments, there are a great number of other Sutlars and Tradſmen, which follow the Armie, as Drapers, Marchants and others, which are all lodged in a quarter by them ſelues a

part;

part; to the end that thoſe which haue neede of any thing, maye goe preſently thither and buy it. And this is the reaſon why all of one profeſſion are lodged in a ſtreete, or two rowes, leaving a large ſtreete betweene the principall Tradſmen of ſome 200 foote or there abouts, which ſhall ſerue as a Markett-place, vvhere all things neceſſary aſwell for the ſuſtentation of man as other wares are daylie ſould, which are brought thither by the Countrie men, and others. The other rowes which are of an other profeſſion, haue their ſtreetes more narrow as 15, 18, or 20, foote. Thoſe which are of a contrarie profeſſion haue a ſtreete of ſome 30, or 40, foote, as the place will afford it, and the quality of the marchants. The Butchers quarter is ordinarily made in one of the furtheſt corners of the Campe, becaûſe of the garbages, and panches of the Beaſts they kill, which they are toburie without the quarter in a hole or a ditch digged for that purpoſe ſome 200 foote without the entrenchment, that noe euill ſent or filthy ſtinke maye cauſe the infection of the aire. If the Campe be quartered by a riuer-ſide (which one muſt ſeeke to doe if it be poſſible) it will not onely be able to furniſh the ſouldiers with water for their accommodation, and to preſerue them on that ſide from an ennemie, but alſo wilbe good for the ſhipping, which maye bring thē all manner of victuals and commodities as experience hath ſhowne in diverſe ſieges, which if it ſo fals out then the market place is made by the river ſide in the ſame place where they ſhould draw in armes being 300 foote broad or there abouts, without having any Hutts in all this plaine, that they maye not hinder the entrances in, and going out of the ſhipps, from whence they fetch all things neceſſarie, aſwell for amunition, as for victuals, and the Marchants, Sutlars, and Mercers and others following the army are lodged on this ſide, and ſeparated by ſtreetes ſome 12, 15, or 18, foote, according to the ſite and commodiouſneſſe of the place, as wee haue ſaid aboue.

In the quarter of the Maſter of the ordinance is often lodged the Commiſſarie of the Victuals, and his Conductours, as wee haue ſaid before, and that when as his magazine is not very great in reſpect of the place, as alſo all the other officers, over which the ſaid maſter of the ordinance commandeth, as the Commiſſarie of the ordinance, his Conductours, the Maiſter gunner, and Gentlemen of the ordinance and the ordinary Gunners. The Commiſſarie of the Amunition, with his traine, as Carpenters, Smiths, Water men, Pioniers, Miners, and others, all of them being lodged by themſelues, that one maye finde their lodgings the better. The Maſter of the ordinance hath commonly the gentlemen of the ordinance lodged within his circuit, that they maye be ready vpon any occaſion to receiue his commaunds, and to execute them as the Generall of the Armie ſhall thinke good, as appeareth by the Figure 122: In which A is the place ordayned for the maſter of the ordinance: B, the quarter of the Inginiers, the Commis and his conductours, C, the quarter of the Carpenters, belonging to the Armie. D, The quarter of the Carpenters which attends vpon the ordinance: E, the quarter of the ſaylours following the traine of the ordinance. F, G. the Pioniers quarter. I, is the maſter Gunners haueing 100, or 150. Canoniers vnder him, and the Prouoſt marſhall of ordinance. H, The Miners quarter. L, the Magazine for the amunition, and his Commis: E, the Magazine for the ordinance; with his Commis, M, N, the Magazine for the Victuals, and O, a place where the waggons ſtand: but when they feare noe ennemie then this place is appointed without the Campe ſome 200, 300, or 400. foote without the entrenchmēt. But when there is any doubt, or that the waggons maye giue any hindrance being ſett without, they appoint them ordinarily to ſtand on that ſide by the maſter of the ordinance his quarter, where alſo the Waggon maſter is lodged, with his lieutenant and their conductours, the better to keepe all

things in good order, and that they maye presently be employed vpon any occasion, when the waggon-master shall call for them, and for the better vnderstanding hereof wee haue made here a draught of it, as appeareth by the Figure 122.

Figure 123.

HAving described the particular lodgings, and quarters of euery companie of a Regiment as well of foote as of Horse and other officers, it will be requisite to represent them together in a Generall quarter. And because exemples are of great vse: I will take first this Figure 123, which was his Excel. quarter before Gulick in the yeare 1611, G is then the quarter and tents of the Generall: I the quarter of the Master of the ordinance K the officers of the Armie; L the market place, where all the tradsmen and marchants stand, which followes the Armie, as we haue said before. F & H are the French Regiments, namely F, Monsieur Chastillon his Regiment, H, Monsieur Bethunes. A, the Regiment of Count Ernest of Nassou : B English companies commaunded by Monsieur Medkercke Lieut. Colonell to Generall Horatius Vere. C are 8, companies of Frizes. E, are 6 Germanie companies. D the 4 companies of the gards, to which quarters are added the number, which shew the length, and the bredth of euery quarter in particular, also the length of the streets, & the greatnesse of the whole quarter in Generall.

Figure 124. *&* 125.

ANd because commonly the Captaines, after their souldiers are hutted, build Hutts in the place, where their tents stood, being warmer, & cooler against the sunne, and more durable: I thought it not amisse to represent the forme of them: A, then is the Captaines Hutt, B his Kitchin. C, his stable, D. the place where his fourrage lies. E, is the streete betweene the Captaines lodging, which is 8 foote. the scale noted by the numbers 124 and 125 will shew the depth and bredth of the said lodgings, and the largnesse of the streets.

Figure 126.

THe Figure 126, is a quarter of Horse and foote, whereof A, is the Generalls lodging. I, the lodging of the master of the ordinance. G, L, F, H, are foure Regiments of Horse. B, C, D, E, M, N, O, P, are 8 regiments of foote. K the Market place for the Sutlars; the Halfe squares 1. 2. 3. 4. 5. 6. 7. 8. 9. & 10. are the places of defense, to hinder the giving on of an Ennemie, whereof euerie face is about 100 foote (as also in the Figure 123. are the exteriour angles 3, & 4) to the intent that one maye lodge more men in them to defend the skirt A B, the Overtures 13, 14, 15, & 16, are the avenues, passages and entrances into the generall quarter: whence it is necessarie, that a Quartermaster Generall ought to haue true notice of the number and qualitie of the Regiments & companies, that he maye dispose of them according as the place and the nature of the ground will afford, and for the better effectuating of what is said before, it would be good, to draw out a draught of the greatnesse of euery Regiment in paper, and aboue it to put the colonels names, to alter and change them according to the accommodation of the place & the number and greatnesse of the Regiments, setting them downe in two, three or foure rowes, or in length if the Entrenchment be by a river-side, lodging the Nations which cannot agree well together as farre asunder as possibly may be one from an other,

to

to prevent miſchiefs,quarrels,and other diſorders,which maye happen betweene them. If he quarters the Horſe with the foote,the Generall of them , ought to haue his quarter in the ſame front as the Generall of the Campe hath,or betweene the troupes of Horſe,being not farre diſtant from the ſaid Generall, and his front, and there muſt be,if it be poſſible,an overture made of 300. or 400,foote, that one maye haue the perfect ſight of the Generals quarter towards the place of armes, for to draw in and out. The ſutlars and marchants,which follow the Armie ought to be quartered behinde the Generals quarter , on that ſide where the maſter of the ordinance lies : but the Butchers ſhambles,as is ſaid before,in one of the corners of the campe , or if they be within,to be ſtricktly commaunded to carry out their offald and filth out of the Campe , or els to digg vp great holes to caſt them in to them,that by ſuch noyſome ſmells the aire maye not be infected.

The 29 Plate , Figures 116,117.118,119,& 120.

AT the ende of the ſaid 200, or 250, foote, the entrenchment is kilſpitted made by the ſouldiers for nothing,euery companie againſt his owne quarter,if it ſo falls out,which entrenchements are (as we haue ſaid ſome 6,7,or 8,foote more or leſſe,as neceſſitie requires. For when one feares an Ennemie,it is needfull that the entrenchements be made ſtronger,and greater,them when there is no appearance to be attempted: in the midſt of theſe entrenchments there maye be made ſpurrs, & redoubts ,on euery ſide of ſome 4,5,or 6,rod,for the better defending of the ſaid trenches : for from them they maye be diſcouvered all alonge,and ſo by night or otherwiſe they maye hinder an vnexpected attempt, being diſtant one from an other ſome 40,or 50 rod,according to the greatneſſe of the ſkirts of the trenches. The reaſon why one maketh theſe ſquare redoubts is,becauſe others cannot be ſo ſoone made,otherwiſe I ſhould be of the opinion that one ought to make great flanks,and large ſkirts,to draw the more men to flancker thē, and not to entrench the inſide (to wit in the entrenchments of the campe) as appeareth by the entrenchment A B C, Figure 116,which would make a better defenſe , if one ſhould aſſault the ſquares D,E,F,G. It is true,that when one hath paſſed the entrenchment,that the ſpace A & C,being open, would be ſooner taken in then the ſquare : but I leaue this to your conſideratiō, if when ye haue loſt your trenches,the ſquare redoubts maye be kept,in regard of their ſmallneſſe and the fewneſſe of men that mans them,to wit,ſome 25,30, or 40,men at the moſt : now for the better preventing of ſuch a danger,ye maye make the lines, and entrenchments D, F, leaving onely a gapp open of ſome 3, or 4, foote,for an entrance in and out vvith a drawbridge, and ſo this would be as difficult to be taken in as the whole ſquares ; ſo that I ſhould rather reſolue to make the entrenchment of a Campe with ſkirts of demy-ſquares : ſo much the greater on the outſide (as is ſaid) without makeing whole ſquares,or redoubts. For in ſo doing the defenſe would be much better,and the comming to defend it more commodious and eaſie. Thoſe which finde the other manner better maye make vſe of it , for my owne part I rather approue of theſe Demy-ſquares. The Entrenchments which are made without the encloſſure of the Campe,as thoſe which encloſſe a towne,or for to cutt of the paſſage of an Ennemie,to hinder their Victuals & ſuch like things ought to be made with ſtrongh redoubts as Prince Maurice did at the ſiege of the Grave , where the Ennemies army lay cloſſe by his campe,not daring once to attempt the paſſage : becauſe of the ſtrongh entrenchment,which he had made by the ſaid ſquare-redoubts,being not further diſtant one from an other then ſome 50,or 60,rod,and about as much

alſo vpon the Entrenchment, which were made (as I haue ſaid) in the forme of Bulwarks, and within them were the ſaid ſquares, which in my opinion are exceeding good in ſuch entrenchments, which are made without the circuit of the quarter, eſpecially, vpon the Avenues that they maye lodge in them ſome 25, or 30 men to gard them, & to hinder an Ennemies paſſage, but when one is not reſolued to make the ſaid entrenchments like Bulvvarks, there ought to be made at the leaſt ſuch ſquare vvorks as the Figures 116, & 117, demonſtrate, becauſe they are wholly encloſſed, having but one entrance as narrovv as poſſibly maye be, being advantagious aſvvell vvithout as vvithin. For as long as the Approches are not much advanced before, and about the towne, they maye ſend men vnto them, and occaſion many hindrances, if they be not vvell entrenched: The Figure 117, will giue vs clearely to vnderſtand, that vvhich wee come to ſpeake off, the ſquare D, E, F, G, being the ſame of the ſquares of the Figure 116, which is an entrenchment running round about the tovvne, vvhich is beſieged, and is as farre diſtant from it at the leaſt as a muſkett can vvell beare, beginning and ending at the entrenchment of the quarter; D E, is the outſide of the Redoubt contayning 4, rod, or 48, foote; the ſpace marked I, is the talud of the parapet; 2, the ſuperficies thereof; 13, the foot-banck; 5, the ditch eight foote broade, and 6 foote deepe, as ye maye more plainely vnderſtand by the Figure 118, which is the Profile of the ſaid entrenchment, whereof the height, and the bredth are noted here, the bottome of the ditch being 2, foote vvide, and conſequently euery ſide of the talud is the halfe of the height, or depth, the foote banke in the baſis 3 foote, a foote high, and aboue 2, foote. And there ought to be one the outſide of the parapet an edge of ſome 2, foote, vvhich vvas forgotten in this Figure 118, but ye maye ſee it marked in the 120, A, T. And ſeing the ſaid ſquares or Redoubts are chiefly made vpon the *Advenues* and paſſages, to hinder thereby the attempts of an Ennemie, vvhich ſecks as much as poſſibly maye be to keepe a free paſſage, and entrance into the towne beſieged: It is ſometimes (for ones better aſſurance) neceſſarie to vſe the greateſt care & perfection to hinder him; ſo that thoſe ſquares be made like litle Bulwarks, as appeareth by the Figure 119, and then the ſides of theſe ſquare workes are greater then thoſe aboue, according to the qualitie of the paſſage, their curtaines being at the leaſt of thoſe proviſionall Forts ſome 4, rod, according to vvhich the other parts being proportioned as the table of our dimenſions ſhevves, the faces F, C, & D, E, 3½ rod, the flank C, A, 103, rod, and the line of the gorge 1. 22, rod, the Rampart as almoſt all other proviſionall vvorks are onely made of 6, foote high at the leaſt, and at the higheſt 9, or 10 foote, makeing the baſis of 14, or 15, foote, and 3, or 4, foote of height vvith the ordinary taluds, vpon vvhich is made a parapett of 7, or 8, foote broade, & 5, or 6, foote high, with a foote banke ſome 3 foote with the taluds, according to the quality of the ground, to wit, ſometimes but a foote high, and aſmuch Talude, and otherwhiles but halfe a foote onely, then one ſupputes hovv vvide the ditch vvilbe according to the ſaid Rampart, being euery vvhere 6 foote deepe or thereabouts: And vvhen one raiſes the rampart aboue 6 foote, vvhich is vſually made in proviſionall fortreſſes, vvhereof the curtaine is 5, rod or more; I thinke it vvere not amiſſe, to make in the ditch a foote banke after the faſhion of a counterſcharfe ſome 3 foote, that if neede be the muſkettiers maye runn along it, rayſing the parapet thereof aboue the plaine field, as much as the ſaid rampart exceedeth 6 foote in heigth, or ſomevvhat leſſe, as the draught ſhewes, vvhich vve haue made thereof marked vvith the number 120, vvhere vve haue raiſed the parapet 2 foote higher then the field, as likevviſe the edge of the ditch', and cutting the Talud of the ditch tovvards the ſame place ſome 3 foote, makeing together 5, foote, vvith

the

the allowance of a litle Talud, as commonly one giues to parapets, to ſerue as a parapet to the ditch, and there to be vnder covert, and ſeing there reſts yet three foote, before ye come to the bottome of the ditch, ye maye make a ſecond foot-banke, a foote and a halfe high, that ye maye the better deſcend from the other to charge & diſcharg your muſkett, while the other are a giving fire, and for to knovv the greatneſſe of the parapets, and hovv vvide the ditch muſt be anſvverable to it, vve vvill make here this calculation thereof followving.

Before vvee come to the ſupputation of the ſaid profile (Figure 120) vve muſt ſet dovvne 6, in the place of a 5, for the line S,R. To marke out 10, for M, K, & an O omitted at the interſection of F,H, and of a paralell through E, to B,C.

ABCD.

A D, makeing 14. foote, BC, $9\frac{1}{2}$, the ſumme being multiplyed by C,G,3, the halfe vvilbe $35\frac{1}{4}$ for the ſuperficies A B C D.

BEFI.

F,H,5, being multiplyed by I, H, $\frac{1}{8}$ the halfe of the product vvilbe $1\frac{1}{4}$ for the triangle F,H,I, then F,O,1, multiplying the halfe of O, E, ye ſhall haue 2, for the triangle F,O,E. Finally, the ſumme of O, E, 4. & H,B,6, multiplyed by 2, the halfe of O, H, ye ſhall haue 20, to vvhich add $3\frac{1}{4}$ for the tvvo triangles abouesaid, ye ſhall haue $23\frac{1}{4}$ for the ſuperficies of B E F I.

L M K, and all the raſing.

The halfe of L M, being multiplyed by M,K,10, ye ſhall haue 10, for the trianglo L M,K: to vvhich add A B C D $35\frac{1}{4}$ & B, E, F, I, $23\frac{1}{4}$ there vvill come for all the raſing $68\frac{1}{2}$, vvhich ought to be equall to that vvhich is voyd, M N O P Q R S T, but to the end we maye reſolue this by the Trapeze M, T, S, R, we will ſubſtract from the Summe abouesaid the two Triangles M N O, $4\frac{1}{2}$, & O P Q, $1\frac{1}{4}$, vvhich make $5\frac{3}{4}$, and vvill remayne $62\frac{3}{4}$ for the trapeze M, T, S, R, which diuided by the depth which is 6, it will giue $10\frac{11}{24}$ the Talud exteriour 6, with the interiour 3, makes 9, the halfe is $4\frac{1}{2}$, vvhich added to $10\frac{11}{24}$ ye ſhall haue $14\frac{27}{24}$ for T, M, which is very neere 15 foote, and likewiſe $4\frac{1}{2}$ ſubſtracted from $10\frac{11}{24}$ ye ſhall haue $5\frac{27}{24}$ for S, R, (makeing very neere 6) the proofe is that the ſuperficies of M N O P Q R S T, is $68\frac{1}{2}$ equall to the ſuperficies of the vvhole raſing, the like ye maye doe with all proviſionall fortifications.

The 33 Plate, and 140. Figure.

ABout the entrenchment of a Campe, there are made ſome gapps, avenues, and paſſages for men, and waggons to goe out, and in, which haue noe ditches, or ramparts, ſome being 6,7, or 8, foote vvide, as occaſion ſerues, ſhutt in vvith a vvodden gate, or Turnepikes made of ſparrs ſome tvvo ynches and a halfe thick in diameter, and about fiue or ſix foote high, plated with yron heads at the points, and having tvvo great Iron nailes driuen through them eight or nine ynches long, and blund headed on the other ſide of the thickneſſe of an ynch, halfe an ynch, or thereabouts; they are pointed to driue them in the better into the ground in two places, to ſtopp vp the paſſage, as the 33 Plate, and the 140 Figure ſhevveth, which

which pikes three or foure rowes of them, muſt be driven in cloſſe one to another as high as a mans girdle, vvhich is about 3 foote, or three foote and a halfe, the firſt and vtmoſt rovv muſt be driven into the ground deeper then the other, and ſo the one aboue the other rovv, that they maye not be pulled vp. Theſe are of good vſe alſo to be driuen in vpon the topp of a breach (as S^r. *Francis Vere* did in *Oſtend*) vvhen an Ennemy is ready to giue an aſſault, and that one hath not time enough, to caſt vp a breaſt of Earth vpon it. Theſe and an other Inſtrument called in Dutch a *frize Ruyter*, and by vs a *turnepike* (as alſo your *quadrangular* tanternailes caſt dovvne vpon a breach) are of ſingular vſe, to barrocadoe, and ſtopp vp places. A Turne-pike is made in this manner follovving:

The 33 Plate & 141 Figure.

TO make a turne-pike, ye muſt take a round ſparre ſome 12 or 15 foote longe, and about 5, or 6, ynches in *diameter*, and boore holes through it in many places: ſo that theſe holes meete not one vvith an other, being boored right one vnder another, about an ynch in a *ſexangular* forme, that the circuit maye be divided into three equall parts, and in euery part, ye muſt boore a hole as is ſaid one vnder an other, that the *demypikes* of ſixe foote length, vvell ſharpned with yron heads at both ends, about an ynch or an ynch and a halfe, maye be putt croſsvviſe faſt through the holes of the ſparres 3 or 4, ynches one from an other, euen as the Figure 141 demonſtrateth.

Theſe *turne-pikes* are of a very good defenſe againſt horſemen, to ſtopp a paſſage into the Campe, to ſtand at the entrance into a worke, or vpon the gapp of a worke: They maye be made ſo that yee maye runne them vpon wheeles, to remoue them from one place to an other and joyne their *axeltrees* together with pinnes of yron, ſo that on a ſudden ye maye ſhutt in the paſſages vnto an army, and being ſo joyned ye cannot remoue the one without the other, ſo that theſe turnepikes joyned together giues the longer and better reſiſtance. There are other inventions to keepe out an Ennemie, but having noe leiſure now at this time to treate of them, wee will paſſe them over, and come to handle of the Approches.

OF APPROCHES.

The 31, & 32 Plates, and 127. 128. 129. 130. 131. 132. 133. 134. Figures.

FOr aſmuch as in approches (whereof we intend annon to ſpeake) one muſt of neceſſity vſe ſhowels, ſpades, fire-rakes, pickaxſes, mattocks, hatches, bils, and axſes, to giue the more luſtre to our buyſineſſe I haue thought good to deſcribe them here. And ſeing *Monſieur Doncker* in his life time Controuler of the fortifications in the vnited provinces, and beſides at the ſiege of Gulick Controuler of the princes of *Brandenburgh* and of *Nieuburgh* their ordinance, a man being very ſkillfull in makeing theſe materials, gaue me the modell of them in that true forme as ye ſhall ſee them repreſented here to your view in the 31, and 32 Plates, by the numbers 127, 128. 129. 130. 131. 132. 133. 134. 135. 136. 137. 138. and 139.

The Figure 127 is an ammunition ſpade, whereof the part A B, is a foote high and A, C, two foote, being in all three foote longe: the point A B, is platted with a ſharpe edge of yron ſome ſixe ynches broad, that ye maye ſpitt a foote into the Earth with it.

The

The 128 Figure is a ſhowell, made more hollow, and ſome what greater, then a ſpade, which cannot be vſed with that nimbleneſſe, as the former: becauſe of the great quantity of Earth, which it will take: ſo that for ordinary vſe I ſhould rather adviſe one to vſe the ſpade, for thoſe that are not able, and ſtronge men.

The ſhowel 129, hath a plate of yron onely, being fitt to levell, and plaine the ground, and for this reaſon (in my opinion) ought to be made longer, then the other, becauſe it muſt be vſed with as much ſtrength as the other.

The Figure 130 is a pickaxe, well knowne to workemen, vvherewith ye digg vp a ſtonie & hard ground, into which a ſpade or a ſhowell will not enter.

The 131 Figure is a Mattock, the head whereof is like an axe made bending, which is alſo well knowne, and vſed to digg vp hard and ſtonie grounds.

The 132 Figure is a hatchet, to be vſed with one hand.

The 133 Figure is an Axe, to be vſed with both hands:

The 134 is a leſſe kinde of axe, vſed with both hands not vſuall in theſe parts.

The Figure 135 demonſtrated in the 32 Plate, is an amunition wheele-barrow, which will hold a foote of Earth deepe, and if it be well loaded a foote and a halfe, which wheele-barrow, as the Figure 136 ſheweth, is made of an *icnographick* forme, contayning 16 ynches in length, and 14, or 15, ynches in bredth, and 7, ynches high, the boords being made for lightneſſe of firre wood; ſaving the axeltree, and the handles, which are of other wood ſome 17, ynches long; but the ſhorter they are, the better they are, and that for diverſe reaſons.

The Figure 137 is a bill, to cutt bruſh and braunches with all, and vſefull for the makeing of Bavins, and bundles of bruſh, Gabions, and for other neceſſary occaſions, aſwell in hutting, as to be vſed in trenches & works.

The 138 Figure is a kind of a crooked bill, ſerving for the ſame vſe.

The Figure 139 is a longe ſhowel, or a rake for the caſting vp of Earth out of galleries, to fill vp a moate, and in other dangerous places. And the forme A, in the 31 Plate, is good alſo to plaine the Earth vvhich is caſt vpon a gallerie, to keepe it from fyring, which otherwiſe might happen to a gallerie.

The 33 Plate & 144. 145. Figures.

BEfore wee come to ſpeake of Approches, it is very neceſſarie, that one ſhould gett an exact draught, as well of the interiour, as of the exteriour part of that towne, or fortreſſe, which one reſolues to approach vnto, with all the markes, and obſervations, as namely, of hedges, wayes, hills, valleys, and the like, that ye maye know the better how to order and runne your approches. Ye ought not to breake ground noe neerer at the firſt thē within a muſkett ſhott, or at the furtheſt as farre as a harquebuſſe a Crock can reach, and (as I ſay) ye ought to beginne your trenches, ſomewhat further off from the towne; if there be a commodious acceſſe from the quarter to the trenches, that when neede requires ye maye the ſooner relieue, and ſecond your men in the approches, if the Ennemie ſhall ſallie, or fall out vpon them. For, when the place where you firſt breake ground is a great vvay from the quarter, it vvilbe diſadvantagious vnto you, becauſe ye muſt allwaies keepe in them a ſtronge gard, to repulſe an Ennemy, and to beate them back when they ſhall ſallie out, and while your men are a makeing ready, and coming from the quarter, many good occaſions maye be loſt, before they cann be at hand. Therefore you muſt haue a great care, and circumſpection, where your trenches are to beginn, and where your quarter muſt be made, as neere to and as covertly from the towne as poſſibly maye bee, conſidering well, whither it were not better to quarter

ſometimes the more incommodiouſly, that ye maye beginn your approches in a place of moſt advantage, neere vnto the towne, or place, which ye are reſolved to take in: then to chooſe a place more commodious for your quarter, that would be a hindrance to your deſſigne, by reaſon of the great diſtance betweene that and the approches, or which maye lie too open to Canon ſhott, all which in my judgement ought to be maturely conſidered, that your deſſigne maye not be hindred or fore-ſlowed.

The next thing is for you, to knowe the weakeſt part, and ſide of the towne, or place, vvhere you maye beginn your approches, and which place you intend to gaine. For, it is a great helpe, eſpecially in places regular, to chooſe out the moſt advantagious place. If you ſhould make a breach in a curtaine, betvveene tvvo bulwarks, ye ſhall finde it to be the retyredſt place, the beſt to be defended, ſooneſt cutt off, and the hardeſt for you to approch vnto, therefore would adviſe you, not to beginn there. And if it hath a *tenaille*, then ye haue leſſe reaſon to make any attempt vpon that place, having a retyred angle, and ſo conſequently the cutting of wilbe according to their vviſh. But to approch to the angles of a Bulvvarke, vvhich are angles ſhooting out, being the exteriour parts of a tovvne, or fortreſſe wilbe the eaſieſt for you to come vnto, and the hardeſt for them within to cutt off: ſeing the place is litle, and that the ramparts themſelues maye giue ſome hindrance there vnto.

The place thē being reſolued on, a certaine nūber of ſouldiers (or Commaunded men) are chooſen out of euery Regiment, and Companie to the number of 4, or 500 men, more or leſſe, to goe downe in the night to breake ground, and to beginn the approches. Alſo there muſt be placed a competent number of horſe, and foote, to helpe to guard and defend theſe workemen, if an ennemy ſhould ſallie out vpon them. Theſe commaunded men haue each of them ten ſtivers a night, or more as the danger of the worke ſhall require: they having men (as is ſaid) in armes lying round about them, to defend them as appeareth by the numbers 20.20 : in the 145 figure. Then the Ingenier, who hath the ordering of the approches, ſetts theſe men out in a right (or a crooked) line placing three or foure men vpon every rod, and all in a file, in as right a line as poſſibly maye bee, takeing ſpecial care, that his men maye ſtand as much out of daunger of ſhott as is poſſible, vvhich is done alſo by the helpe of theſe gates, which lies about them in keeping their marches cloſſe, that they maye not be diſcouvered by thoſe of the towne. More ouer, they muſt laye out *Sentinell perdues*, before and round about them, which if they heare, or ſee any thing, maye giue the alarme ſilently before an Ennemie can fall vpon the workemen: For the alarme being once giuen, theſe gards are to draw vp, and helpe to defend the Workemen. But if they ſee that the Ennemie ſallies out to ſtronge for them, theſe gards then maye drawe into theſe *Corps de garde* made purpoſely for them, and withall the commaunded men muſt quitt their worke for that time, and bringe off their armes, ſpades, ſhowells, and mattocks; but if haſt and neceſſity conſtraines them, to defend themſelues; then they muſt betake themſelues to their armes, and caſt away their materials, retyring ſoftly (with the gards abouesaid) if they cannot make the place good, to the *Corps de garde* made firſt for their retreate. Theſe workes ought to be ſtronge, and able to repulſe and keepe out an ennemie, yea it often hapneth, that they vpon a diſorderly retreate, into the towne maye be followed, and beaten back with the loſſe of many men, even to their very moate ſide, and that the Beſiegers maye diſcouver the ſtrength, or weakneſſe of their vvorks, and ſpie out ſome advantages for them. The Ennemie being beaten back, the commaunded men maye fall inſtantly to their vvorke againe, and being

being gott some 3 foote deepe, and casting vp the Earth towards the tovvne, they maye worke with the more safetie, and out of daunger. And for this reason euery souldier will make as much hast as possibly he can to gett into the ground for his owne preservation, and the Earth being cast vp thus out of holes, they maye afterwards repaire it, and make thereof a large trench, and ditch, namely, (as is said) 3 foote broade, and 3 foote high, casting the Earth vpon the edg of the trench, and the next day maye make it 6 foote broad, and six foote high: for the larger the trench is, the higher ought the parapet to be; becavse othervvise, they might be discouvered by those of the towne, and so your men maye be the better vnder covert, and lie safer in the said approches. And becavse this cannot be done so exactly by night, fresh commaunded men are sent downe in the morning from the quarter to repaire, and enlarge the trenches, and if the trenches be so large, and so high, that one cannot well discover the fields round about them, then ye must make a foot-banke or two, for the musketters to come to the topp of the trench to giue fire over thē through musket baskets, which is done most times when a sapp is begunn: At the first entrance into the trenches, or approches, ye make a square worke, or two, called Redoubts, or a *Corps de garde* being distant one from an other some 40, or 50, rod, that in them ye maye keepe a stronge gard the daye following, and the Ingenier, who hath the mannaging of the approaches; maye so order & encourage his men, that the said *Corps de garde* maye be in defense before daye, to the end, that if the Ennemie should sallie out vpō the trenches, that from the same *Corps de garde* they maye be beaten back: the bredth of euerie side ought to be some 4, or 5, or at the most 6 rod, and the ditch broad & deepe as necessitie shall require. They ought to be made in my opinion in such a manner, that the two opposite angles doe enfile the said thrench as appeareth by the Figure 117, Plate 29, and by the *Corps de garde* D E F, Figure 145. For then the said trenches will not onely lie open vnto it, but also one maye discouver the fields round about it. But if it be not found good to make them so, then the best way in my judgment vvere to make them out of the Trenches a rod and a halfe, or at most two rods distant from them: so that the said trenches ought to be betweene the towne, and the said *Corps de garde*: one of the sides must be paralell to the said trench that ye maye march by it in the night, both with men and waggons, and to draw vp the ordinance betvveene the said *Corps de garde*, and the Trench, and so the said *Corps de garde* will flanke the said trenches on that side where they lie most open. as ye maye note by the *Corps de garde* in the 4, Figure, 145 & 33 Plate.

After your commaunded men haue vvrought almost to the breake of the day, then they must be drawne off (without beating of a drumme) by a Sergant or the Quartermaster of a Regiment, and being returned to their quarter the Sergant shall deliver the note of the number of his men to the Quartermaster of his regiment, and the Quartermaster to the controuler of the works, vvho to that end comes to visite the said worke and to see if there were as many men as was appointed, least there should be any fraude committed therein. Then the Controuler is to giue the Quartermaster his attestation for the worke men, or in his absence the Ingenier giues the said Certificate, and the Quartermaster brings it to the States, who giues an ordinance vpon it to the Treasurer, and so the Quartermaster receiues money for the workemen of euery companie, to wit, ten stivers, giues it to the Sergants & the Sergants to the souldiers of every company.

The reparing of the trenches are made by the vndertakers (as wee haue said) for so much, or so much the rod, according as one desires to haue them large and spatious, as some times 6, 8, foote, or more, as necessity requires. For oftentimes they

muſt be ſo broad, that a waggon loaden vvith fagotts, Bruſh, or Gabions maye goe in them. The wages of euery ſouldier is then augmented ſome times to 15, 20, or 30 ſtivers a day, when there is evident daunger, as there is commonly, at laſt before one beginns to ſapp: for the muſkettiers playing continually vpō the points of the Trenches, where they imagine that the approches will run, kils many men: yea ſo that ſometimes they are forced to giue ouer the worke, becauſe many men are not able to worke in it, and being too hott, they putt in a reſolute man or two, into the vvorke, promiſing to giue them more then ordinarie if they vvill haſten the worke, and this is conſiderable, whither this extraordinary expence be not profitable for the advancing of the approches, and gayning of time, then to ſpare a litle money and foreſlow them: For experience hath many times taught vs: that expedition in ſuch caſes hath wrought many great effects.

When you are approched ſo neere your Ennemie, that by reaſon of their continuall ſhooting vpon your points ye cannot advance your trenches any further; then you muſt beginn your ſapp, which ye ſhall runne, if it be poſſible, directly vpō the point or ſide of the Bulwarke, which ye intend to take in, as the point, I, & K, Figure 145, demonſtrate. And becauſe tvvo men at the moſt can but vvorke in them, theſe ſapps are ordinarily taken on by ſome reſolute ſouldiers for ſome 7, 8, yea or 12, gilders a rod, as the danger requireth: they firſt make the ſap ſome 3 foote broad, and about 3. 4. 5. or 6 foote deepe according as the ground is, either high or lovve, then theſe vndertakers or others are to repaire the Sapps, and receiue for their paines 6. 7. or 8, gilders a rod, and ſo make it 6 foote broad, or thereabouts caſting vp the Earth on both ſides, that they maye be the better vnder covert, and the ſafer from the Ennemies ſhott.

According to which we haue made the Figure 144, whereof P, Q, are two Bulwarks. A is the beginning of the Approches, A, B, the firſt trench or line vvhere the workemen breake ground, carryed in ſuch a manner towards the angle R. (in caſe the ſame line be lengthned and comes out of the *Corps* of the Fortreſſe) in the angle B is made a *Corps de garde* for the aſſurance of thoſe, vvhich garde the trenches, as appeareth by the Figure 145 to the letter B. At C is made a line towards the angle S, which muſt be drawne in ſuch a ſorte, that if it be lengthned, it vvill fall on the outſide of the Corps of the fortreſſe Q. vvhich is continued (as the ſaid Figure demonſtrated) to I, the parapet of the covert vvay, vvhere one beginns a mine to blowe vp the counterſcharfe, that ye maye come to the brinke of the moate. From D, is drawne the line E, K, to aſſure one the better of the encloſſure K, E, I, betweene K, E, &, I, E (before ye come to peerce through with your ſapp) ye ought to make the lines L, O, & F, M: that from theſe lines you maye giue fire vpon the Ennemies Muſkettiers, ſetting along vpon theſe lines muſkett baſketts that ye maye play continually vpon the beſieged, that vnder the favour thereof, you maye advance your ſapps towards the faces R, T, & V, S, as the ſaid Figures 144, & 145. ſhewes. If the *Corps de garde* be in ſome eminent places as they ought to be (if it be poſſibly) after ye are advanced to them, ye make a batterie vpon them, but if there be one peece of ground higher then another, that is more commodious, which ye may chooſe for your batteries, as wee haue done here in the Figures G, H, P, O, X, Z, Y, Figure 145.

Figure 142. 143.

WHen ye beginn your trenches of Approche, ye commonly make ſome batterie, that vnder the favour thereof your men maye worke forward with the

the more ſafety, and hinder the Ennemies from falling out, vvhich vvould much foreſlow your works. Your Batteries then are made firſt in ſuch a manner that they maye beate vpon the Parapet of the ramparts & Bulwarks of the towne, to diſmount the ennemies ordinance, and for this reaſon you muſt raiſe your Batteries high according to the height of the ramparts, ſo that your Canon maye play freely about two foote lower, then the topp of the parapet, according to which, and in conſideration of the diſtance, ye muſt raiſe your ſaid batteries, takeing heed that your Canon be planted vpon a plaine ſuperficies, and elevated ſome 13, degrees, when the diſtance is farre off: ye muſt not raiſe them ſo high as when the batteries are neere vnto the place: ſo that ye muſt either raiſe, or ſinke them, as neede ſhall require. Ye make your batteries, and platformes according to the greatneſſe, and number of your peeces: for a *Demy-Canon*, being ſhorter then a whole, of neceſſity the platforme of the one, muſt be longer, and deeper then the other, and ſeing a Canon being mounted vpon its Carriage, is ſome 16 or 18 foote longe; it is evident, that the batteries ought to be made for recoyling at the leaſt 10, or 12 foote longer makeing together 28, or 30 foote: 12, or 15 of the firſt foote tovvards the parapet, muſt be vnderlayd with thick & ſtronge oken plancks and the other with hurdles, when ye haue not plancks enough: vpon the ſaid batteries ye make a parapet 12, 16, or 20 foote thick or thereabouts, with port-holes for your canon as the Figure 143 demontrateth. Sometimes ye ſett vp Gabions 6 foote high and 3 foote broad filled with Earth, for your ordinance to play out of, leaving a litle ſpace betvveene them, to putt out the mouth of your Canon, which ſpace ſo ſoone as the Canon is diſcharged is preſently ſtopped and blinded vvith a bundle of bruſh full of leaues, that the ennemie maye not diſcouver the port-holes, but when you make your batteries vpon the Counterſcharfe, or vpon the brinke of the moate, then the port-holes aſſoone as your Cannon is ſhott off, are ſhutt with doores of thick oken planks muſket proofe, that the ſaid port-holes maye not be ſeene. Sometimes ye ſett onely Gabions vpon the parapets of Batteries which containe 7 foote in Diameter, and 10 in heigth, yea oftentimes ſett 3 rovves of them vpon he ſaid parapet, which make in all 21 foote thick as appeareth by the Figure 149, & the 34, Plate. There are vſually made three ſorts of Gabions, to wit, the ordinary of 6 foote high & 3 foote wide: the middle ſized 7 foote high, and 5 wide, and the double Gabions 10 foote high, and ſeuen foote wide in the mouths, as appeareth by the Figures 146. 147. & 148. the platforme or bed, is a foote higher behinde then before, or by the parapet to the end the peeces maye not recoyle too farre, as alſo that with the more eaſe they maye be drawne vp towards their port-holes, and ſeing euery peece is broad at the Axeltree ſome 7 foote, ye muſt allow 5, or 6 foote for a ſpace betweene the Axeltrees of each peece one both ſides & ſo haueing 4, 5, or 7. foote diſtance betweene them one maye the better come to the mouths of the peeces to lade them, for it is neceſſary to haue roome enough vnto both ſides to come to them readily, that being diſcharged ye may draw them vp againe into their places.

If the ſides lye open, they muſt be blinded vvith a parapet of Earth or vvith Gabions; at the furtheſt ende of the batterie, ye muſt make a cellar or a place for your powder bullets & match and other neceſſaries, for the Conductour, which ſhall giue out the pouder, the bullets, with a gentleman of the ordinance, who ſhall giue order to the Canoniers, when and how often they ſhall ſhoote, and without whoſe knowledge, and Commaund they ſhall doe nothing: the amunition which is there muſt be covered, with horſe ſkinns and haircloth to prevent the danger of fyring, and to that end this hole is made in the Earth. The circuit of the batterie is oftentimes trenched about as the others in the approches are, but

otherwiſe, vvhen an ennemie is not to be feared, onely is compaſſed about with match bound vp with ſtakes, that noe man vnawares or without leaue maye come within the compaſſe thereof. The entrance into the ſaid batterie is made ſlooping, that one maye the better come vp, and goe downe, and chiefly that ye maye with the more eaſe draw vp the Canon into them. The Batteries muſt not be farre from the trenches, but that vpon all occaſions they maye be ſeconded.

According to which directions ye ſhall eaſely make all ſorts of batteries, as for exemple: The Generall would haue you to make a batterie for foure peeces of Canon, ye muſt take for euerie peece at leaſt 12 foote, in length: ſo that for the foure peeces ye muſt haue 48 foote, and then for the two vtmoſt peeces each 5 foote makes 10 foote, which with the 48 make in all 58 foote, vvhich ſhalbe the bredth of the ſaid batterie for 4 peeces, excepting the Parapets & Taluds, vvhich oftentimes haue as much Talud, as heith, and ſometimes the halfe, and for the depth, ye muſt take 28, or 30 foote, or thereabouts beſides the Parapets and Taluds, the firſt 12, or 15 foote are layd with Oaken plancks, and the other vvith hurdles, for whole Canon, (as we haue ſaid) vvhich carrye a bullet of 48 pound weight, but ſome two foote leſſe for the halfe Canon, and for other peeces accordingly; The ſaid plancks muſt be layd both at length and ſidelings, and the hurdles along the peeces, as appeareth by the Figure 143, in which H is the ditch, G the edge, F the Talud, E the parapet, B the bedding of the plancks, C the Talud. The Figure 142 is the profile of the ſaid batterie 8. 12 is the cellar, where the powder ſtands, which ought to be ſomewhat neerer the batterie then is marked here, and was made in the ſame time as the battery was, and the Earth which is caſt vp out of it, is vſed to raize the ſaid batterie: when ye haue not earth enough to make vp the batterie with all, then ye muſt digg round about it, as we haue ſaid in this exemple 143. But for a batterie, which is made vpon the brinke of a moate, it is not commonly ſo high, nor taketh vp ſuch a great ſpace, as this preſent batterie doth; becauſe the ground will not afford it, and that they cannot ſoo well cover ſuch places: ſo that one is conſtrained to entrench them more narrowly, vvithin the place to be the more ſecure vnder covert from the ſhott of the beſieged, which forbeares not to offend, yee alwell by hand granadoes as otherwiſe.

How to pierce through a Counterſcharfe, and to make a Gallerie over a moate.

The 34 Plate, and 150. 151. 152. & 153, Figures.

WHen you are come with your ſapp to the parapet of the covert way, then you muſt make batteries to beate dovvne the flancks, and the other places of defenſe of the Fortreſſe or towne, and vvithall ye beginn then to pierce into their counterſcharfe: and for the better effectuating thereof, if it be high ye muſt make an entrance into it through a mine, ſo that your diſcent into the moate maye be made leuell with the Superficies of the water of the moate, which diſcent muſt goe downe ſlanting as F, L, & the Figure 150, G, H, I, K, is the furtheſt end of the mine, or the diſcent into the moate F, G, the height of the mine, being 6 foote or aboue, and ſome 5 foote broade, or ſome what more, that the Earth vvhich is taken out of it maye the more commodiouſly be carryed away, and that the more men maye march in front in it. Before ye gett in the ground at the entrance ye muſt vnderprop it with poſts as the former F, G, H, ſhewes, vntill ſuch time as ye are gott ſo deepe, that ye are vnder the Earth, and then for keeping the earth from falling

downe

downe, ye muſt driue in poſts on both ſides, and laye oaken plancks (which are not very broade croſſe vpon them, continuing ſo as you advance your mine in keeping the Earth from tumbling downe : theſe poſts and plancks muſt ſtand and joyne cloſſe one to another as ye ſee repreſented by the Figures 150, & 153, Plate 34. In which F, G, H, is the entrance into the mine to deſcend into the moate. The 3 firſt poſts (becauſe ye are not yet entred much into the ground) are made in that manner as the Figure 152 demonſtrates, the reſt are ſett in that forme, as the Figure 150 ſhowes, in ſuch ſort that I, K, is the entrance into the Counterſcharfe. If the ground lye lowe, and that ye cannot gett into the counterſcharfe after the manner abouesaid, then ye muſt continue your ſapp, to the brinke of the moate, and that ye maye keepe it from fyring, ye muſt cover it ouer with fyrre plancks and caſt earth vpon it, that your men maye worke with the more ſafety and that ye maye hinder the beſieged from caſting in of granadoes, and other fire works, ye muſt place muſkettiers round about the approches, which if they perceiue the ennemie caſt any fire workes from the rampart vpon it, they maye giue fire preſently vpon them.

Being gotten through the Counterſcharfe and come to the edge of the moate: ye preſently caſt abundance of fagots, bruſh & earth into it, to fill it vp, and one or two of your reſoluteſt men leaps into the moate to lay them right vpon the face of the Bulwarke, that as you fill vp the moate to come to the ſkirt of the Bulwarke ſo ye maye advance your gallery till you are over in ſetting your poſts forward, and laying plancks over it and caſting Earth vpon the gallerie, which muſt be 7 or 8 foote high, and 6, 7, or 8 foote broade for the larger it is ſo much the better and the more men maye march in Front in it : the poſts, or ſupporters maye be ſett ſome 5, or 6 foote diſtance one from an other, vvhich maye be plancked on the in ſide, and on the outſide with oakē planks, and the poſts being ſome 6 ynches thick, the gapps, or ſpaces betweene then, are filled with Earth, to reſiſt the force or violence of canon, and aboue the gallerie, as is ſaid , ye caſt vpon it a foote or halfe a foote of earth thick, and then ſpread it abroad with a fire-rake to keepe it from fyring, which fire-rake is deſcribed in the 31 Plate, by the Figure A.

The 151 Figure.

WHen you haue putt over your gallerie (as we haue ſaid) then you muſt beginn to mine, as the place, and as the Aſſaillants ſhall finde it beſt, either vpon your right, or left hand, high or low , if the water hinder you not mining & worke ing in this manner following : The Earth which you digg out of the mine, muſt be carryed away in wheelebarrows through the gallerie whither you will. If you pleaſe you maye caſt it into the water towards the angle of the Bulwarke, and ſo fill vp the moate with it, if it be not incommodious for you to carry it through the gallerie : But on the other ſide, ye muſt marke well the turnings of your mine, which maye occaſion the Beſieged to counter-mine, and ſo to hinder the deſſigne of the Beſiegers. For if they haue once diſcouvered, or mett with the mine of the Aſſailants , they muſt be forced to ſtopp it vp & to abandon it, and ſo beginn another. The Countermines which are made in ramparts , or Bulvvarks vvhen a fortreſſe is new made, being ſome 5, or 6 foote high, and 3, or 4 foote broad , are of ſingular vſe, which doe encircle the place , and from them ye maye heare the leaſt noiſe that is made on the outſide, and which way one workes, and by that meanes maye hinder them the better from myning.

Theſe mines are commonly made in the forme of a *paralellograme* or a long ſquare, to wit, the chamber in which the pouder is layd, muſt be 4 or 5 foote high,

and

and 3 or 4 foote broad, and in length answerable to the ponderosity or weight of the rampart, and according to the breach, which ye intend to make. If ye vvould blowe vp the rampart on the inside, you must peerce into it some 6, or 8 foote, and then ye must make your chamber, but onely 4 foote high, some 3 or 4 foote broad, and some 6 foote longe, according to the number of the barrells of pouder, which you meane to laye in it, and the greatnesse of the wall, vvhich you intend to blovv vp. The reason why the chamber is made here but onely 4 foote high, is to the end that the exhalation finding the least resistance towards the inside, forces it with the more violence and makes therein a greater shaking and breach to the terrour, and hurt of the besieged: when ye would blow vp the vpper part of the rampart, thē you make your mine some what ascending vpwards: if the moate be very deepe, that your dessigne be not frustrate by reason of the water, for your better assurance, ye must make your chamber some 5, 6, or 7 foote high, to the intent that the exhalation maye breake vpwards according to the intention of the Master-miner. But the entrance into the said chamber, as we haue said aboue, must be onely 4 foote high and 3 broad, to the end one maye the better stopp it, and hinder thē exhalatiō from breaking out backward, towards the gallerie, which one ought deligently to prevent, in shunning those inconveniences and mischiefs, which oftentimes by such casualities haue hapned heretofore.

Then having chambred your pouder, and noted well, that those within haue not discouvered it: you must stopp, and shutt vp your mine exceeding firme that it maye take the better effect. To doe this, the best way wilbe to stopp it at E, with two hughe plancks, just at the said entrance at E with great sparrs of timber, and driving them into the Earth, as firmely as possibly may be. The chamber F G H I is 4 foote broad, and F G, & F, I, is sixe foote in length: Oftentimes the bredth is but 3 foote, that one maye be the better assured of the resistance of the posts and plancks. In one of the plancks, which stoppeth vp the entrance E into the mine, ye make a hole in it, to putt your traine through which runns from E, to B, that through it ye maye giue fire to the pouder in the said chamber: After these plancks ye damme vp your mine with good Earth, from E, to B: the turnings C D E, are made to delude the besieged, that they maye not finde out your mine by counter myning; but most often it runns right forward, or somewhat winding. The length of the chamber F, I, (which is here but sixe foote) is made as longe as necessity requireth, but the bredth F G, is ordinarily noe more then 3, or 4, foote at the most: and to weaken the more the place which you intend to blow vp; me thinkes it would be good before ye spring your mine to digg some Holes in some corners that the exhalation may haue the better vent, and easie bursting out. Some are of the opinion that a barrell of pouder will blowe vp 12 foote of Earth, according to which ye may make the said chamber, and lay in as many barrils of pouder as you please, to the end you maye make your breach the larger & more spatious. But seing this is yet vnresolved, I will leaue the judgment thereof to those which haue more experience therein then my selfe.

How one must be prepared against a Siege.

The 35 Plate and 154 & 155. Figures.

HAving succinctly spoken of Approches, Sapps, the descent into a moate, galleries and mines: me thinks it will not be amisse now to treate of the preparations which must be made against a seige.

It

If then one ſhould be ſuddenly ſurprized: ſo that there is noe time to make any outworks, halfe moones, Horneworks or other peeces of fortifications as well looſe, as joyning to the wall, or place: one ought in my opinion (beſides the care that ought to be takē for materials, amunition, and victualls (whereof I doe not intend here to ſpeake) one is to take ſpeciall heede vpon what ſide of the towne or Fortreſſe the Ennemie will beginn and runne his approches, towards what Bulwark he makes them, on which ſide I would make ſome works to hinder an ennemie, as we ſhall declare in the 38 Plate & Figure 159. But if one be advertized of the Siege ſome time before, or that ye imagine, it wilbe good to provide ſuch neceſſaries and to fortifie thoſe places with a more capable defēſe, which we intēd to ſpeake of hereafter (according as ye ſhall finde the weakneſſe of the place to require, & as time will permit you to doe it before ye be beſieged) as well without the towne as within, to make good entrenchments & to provide munition, victualls, and men ſufficient to defend that place, without the Towne, you muſt make Horneworks invented of late yeares, Halfmoones, traverſes, and other works, all tending to hinder the Beſiegers from getting into your moate, and to prolonge the ſiege with hopes of reliefe, ſeing experience hath taught vs, that when an Ennemy comes once to enter your moate, and to putt over his gallerie, that towne or place cannot long hould out: if you haue not made ſtronge workes, entrenchments, and cuttings off without (to giue an Ennemie his handfull, and to make them gaine your works ynch by ynch) which notwithſtanding are not of ſo good a reſiſtance, as is your ſettled, firme, and ſolid rampart. Theſe workes ought to be drawne out according to the greatneſſe of the place, and the men which ye haue to man them. For, if ye haue many of thoſe works, they will require a great many men to defend them ſo that if ye haue not men enough to keepe them, that labour and expence will be in vaine, and ſo an Ennemie maye ſoone become maſter of them. And ſeing in all obſervations, exemples are of great efficacie I haue thought good, and profitable to make you vnderſtand my intention by repreſenting vnto you the Plate of *Gulich* prepared againſt that ſiege, whereof the Bulwarks of the towne are marked by the numbers 2,3,4,5, the Caſtle, which is quadrangular by the Ciphers 6,7,8,9. And ſeing the towne ſtands vpon a low ground, and the Caſtle vpon the ſide 6,9,8, vpon a higher ground: in all likelyhood the approches was to be begun on this ſide, as the Beſiegers did in the yeare 1611, for which reaſon, and to hinder the Approches on that ſide, they made the angles 9. 8. and betweene them the Horneworks c,d, f, the Ravelins c,g, h,b, being not further aſſunder one from an other, but that from the curtaine one might defend the vtmoſt hornes c,d,f. But ſeing c, and f, are very narrow, to wit, onely ſome 24 rod, and ſhoote out farre from the bodie of the Fortreſſe: in my opinion they ought rather and it had beene much better to haue made the angles in the forme of the Raveline c, & f, and ſo haue quitted the ſaid horne-works, becauſe (as we haue ſaid) they were too ſtraight, and narrow, and to haue made them at g, or vpon the curtaine 6, 9, the Horneworks 1, and (alſo whither the Raveline b, could not haue defended the Raveline c, in the place of the angle of the Bulwark 8) and to haue made the hornworke q. vpon the curtaine 7,8, and ſo might haue ſaved the Raveline a. And betweene the two Bulwarks of the towne 4,& 5, the Raveline r,& o, betweene 3,& 4, and ſo haue ſaved the entrenchment n, which runs out farre frō the angle 3, and is of noe great defenſe. The Raveline k, is made betweene the Bulwarks 2,& 3, to take away the entrenchment m, made in a Tenaille, but the ſides being of a very ſmall diſtance, & for this conſideratiō of litle vſe, yea many times hurtfull as experience hath ſhowne oftentimes. The reaſon why I make of the angles 8, and 9, the Ravelins, c, and f, in ſtead of the

Horneworks,is,that the Horneworkes d, & i,might be the better defended,which wilbe reciprocaly defended from the ſaid Horneworks , and will not be ſo farre diſtant from the body of the ſaid fortreſſe. Thoſe which are of an other opinion, maye follow their owne intention and experience, againſt whome I will not contend acknowledging that experience ſtrikes a great ſtroake in all occurrence, ſaving that I am onely permitted to giue adviſe therevpon.

The ſaid Horneworks are made in bredth, and height as neceſſity requires and as they maye reſiſt the forces of an Ennemie,and according to the time they haue to make them. For the firſt one makes a Rampart,or a parapet,ſome 12,16, or 20, foote broade,6 foote high,and a ditch of the ſame bredth of 12,16,or 20 foote,and ſome 6 foote deepe. If one cares not for the expence and hath time, ye maye add to the former bredth 6, 8, 10, or 12 foote more,in enlarging alſo to ſo much the bredth of the ditch,and then the Rampart is made ſome 3.4.5.or 6 foote high,and vpon it alſo ye ſhall make a parapett of 6 foote high,with a foot-banck ſome 3 foote broad,and a foote high,the ditch is enlarged and deepned,according to the greatneſſe of the Rampart, and as wee haue taught in the Plates of our regular fortification before:and the higher the Ramparts be, the entrenchments are the better covered: one maye make them the further from the place,to wit within a muſket ſhott,ſo that there wilbe a better meanes for entrenching, and cuttings off, and to forſlow and hinder an Ennemy from advancing his approches.

The 38 Plate & 159 Figure.

IF one hath not time to make theſe workes abouesaid , as when an Ennemy is neerer at hand, then one did expect : After ye haue obſerved well the place towards which the Aſſaillant makes his account to beginn his approches,as towards theſe two Bulwarks,one might make litle ditches without them as A B C D, which are in the extention of the Capitals beginning in the Angles A,C, of the length of 600 foote,or thereabouts (to wit, that the vtmoſt end B, D, be not out of muſkett ſhott) of the bredth of ſome 6 foote at the moſt,and 5 foote deepe without the parapet , the Earth being playned from the one part to the other, to the end that you maye not hinder the ſight of the muſkettiers , which you ſhall lodg in them , and in ſtead thereof vpon the edg of theſe ſhalbe ſett ſmall muſkett baſketts filled with Earth,eaſie to be removed from one place to an other : It wilbe good for ones better ſecurity to hold there a *Corps de garde*, that if the ennemie ſeeke to beate them from thence , they maye be the more able to diſcharge their duties,whereby(in my opinion)the approches of the Beſiegers maye be much hindred, & being ſo puzled they wilbe conſtrayned euery time to alter thier deſſignes and ſo to beginn their approches againe a good way further off , and more crookedly , as towards B, D, to which being come they can gett noe advantage; ſeing they are enfiled with the angles of the Bulwarks : If they had time to make cheſts in them, or to make them in ſuch a ſort, that the Beſiegers could not driue them out of them,it would be much better.

Of Cuttings off,aſwell generall,as particular.

The 36 Plate & 156 Figure.

IF an Ennemie be gott into the ſkirt of the Bulwarke g, h, and that one hath not time to cutt it off royally, & yet you are reſolued to make him gayne the place

foote

foote by foote, you muſt make the cuttings off f, l, m, whereof n, o, p, is the ditch, makeing the angle of the Tenaille l, as much pointed as poſſible maye be, that the lines f, l, and l, m, maye be the better ſeene from one an other, carrying the outward edg of the ditch n, o, & p, as neere the ſkirt g, h as poſſibly maye be, that ye maye haue the ditch as large as maye be, to hinder the takeing away of the tenaille l. If the whole face be not ruined, but onely the angle of the Bulwarke r, one ſhall make the angle t, from the Tenaille ſ, t, u, (which in regard of the ſmallneſſe of it wilbe better then the former) ſo that on the inſide of the cutting off x, y, z, one maye haue ſpace there to make the ditch as great and as deepe as maye bee: the entrance ought to be in the angle of the tenaille t. But ſeing that fortification is better, which hath two flancked, and flanking angles, ye muſt make the entrances in and out alſo double, to haue the ſame the more eaſie, and if time & occaſion would permit, they may make in the angle t, two iſſues, which in my opinion might be made vpon the two ſides ſ, t, and t, u, as neere the angle t, as one can: and ye muſt note by the waye, that the Bulwarke againſt our intention is made maſſie, and not hollow.

The 38 Plate & 159 Figure.

IF the two faces be wholly ſpoyld, as the Figure 159. demonſtrateth, then I ſhould thinke it good, to make the angles a, b, c, contayning the angle of the *tenaille* b, as litle as maye bee to gaine the better place of defenſe in makeing the ditch, as large and as deepe as is poſſible, as it is here marked out by the lines d, g, & e.

When the Bulwark hath a Catt noted B, and that its angle h, is ruined, then one might ſo order the cuttings off l, m, n, o, & the ditch p. q. r. ſ, t, that the beſiegers ſhould be compelled to vndermine the Catt, and to paſſe the ditch, which the lines p, q, r, ſ, t, repreſents vpon the edge exteriour.

But if the whole Bulwarke be ruined, you ſhall drawe from the midſt of the curtaine of the Bulwarke ruined a privie line marked by the letters h, I, vpon the inſide whereof, ye ſhall make the two ſkirts of the bulwarks, according to our generall methode giuen in our regular fortifications, and the other cuttings off h, k, l, m, n, i, ſhall haue: the other Bulwark B, being alſo ruined, one maye draw the privie line ſ, h, & make within it two other ſkirts, as h, o, p, q, r, ſ, and ſo o, h, k, p, l, wilbe a perfect bulwark, having flancks, gorges, faces and curtaines of the ſame proportion, as the two Bulwarks had which were ruined, and by this meanes euerie place aſwell regular as irregular maye be cutt off. Many other ſorts of cuttings off might be deſcribed, according to the ſituation of the place, and the manner of attempting, by the induſtrie of the Ingenier, which hath the ordering of ſuch cuttings off: But ſeing the like inventions were abundantly practized in the Towne of Oſtend, the Lovers thereof maye peruſe the 25 Plate of this bocke, and ſee what cuttings off was vſed there, the ennemy having poſſeſſed halfe the towne, before he gayned the whole.

How one ought to carrie him ſelfe vpon an Aſſault.

The 36, & 38 Plates, & 156, & 159, Figures.

IF the ennemie prepares to giue you an aſſault, and that his breach be great enough, thoſe within muſt labour by all meanes and ſeeke to ſtopp it & to defend

them ſelues in the beſt manner they are able, and aboue all if it be poſſible to driue in ſome ſtrong piles vpon the top of the breach, which we before haue called *paliſſadoes*, for an aſſault, deſcribed in the 33 Plate and Figure 140, each paliſſadoe having 2 yron pinnes ſome 10 ynches longe, driven through them, as we haue ſaid that by this meanes one may keepe them from comming vp and entring the rampart or breach. Now ſeing the breach ought to be defended by able men, furniſhed with armes fitting to ſuch an end, ye muſt make choiſe of your beſt ableſt, and moſt couragious men, which muſt ſtand vnder the breach to ſecond thoſe which helps to defend it, and ſhall fall on, when they ſee their fellow-ſouldiers repulſed back. On the inſide of the cutting off you ſhall place ſome other troupes of a ſtronger body then the former, to the end, that if thoſe men, which defends the breach, ſhould be forced to retreate into the ditch, that the others at that very inſtant maye ſhow themſelues vpon the top of the rampart of the new cutting off, and if there be any meanes to plant a peece of ordinance or two vpon it (which maye be blinded till the Beſiegers falls on) it will greatly offend them. The entrances, and ſallies to the ſaid breach, ought in my opinion (if the cutting off be in the *tenaille* of the angles t.l. Figure 156, & b, 159) of an eaſie acceſſe, being raiſed as litle as poſſibly may be, whereof the one maye ſerue for an entrance, & the other for a comming out, chooſing the one or the other for the moſt commodious, according to the ſituation of the place. And ſeing the cuttings off (as we haue ſaid before) are eſteemed the beſt, which haue two angles flanking, ye muſt at the firſt make the cutting off, h, k, l, m, n, i: Figure 159, to be raiſed euen with the height of the rampart, or according to the height of the Bulwarks, if they be a litle lower, then the curtaine, if that the batteries doe not commaund them. For in ſuch a caſe, you muſt raiſe it much higher, that from thence (with the more vivacity, and courage) ye maye repulſe the Aſſaillants. But ſeing this cutting off is of a better defenſe, and is much more labour, then the cutting off, a, b. c, ye muſt conſider well, if time will giue you leaue to doe it, if not ye maye make vſe of the cutting off a, b, c, for oftentimes neceſſity hath noe lawe.

And ſeing experience hath taught vs too much what difficulties, one ſhall meete with all in ſuch cutting off: the onely way is in my minde to hinder (as much as poſſibly maye be) the Ennemies deſcent into the moate; which beſides other inventions that are in vſe, maye be done by the meanes of the cuttings off, at the lines a, b, & c, d, Figure 159, which are made here right oppoſite to the angles of the Bulwarkes from one part to an other, beſett with ſmall muſkett baſkets & filled with Earth as we haue ſaid before.

Of Caſemates.

The 37 Plate & 157, & 158, Figures.

FOr aſmuch as we haue ſeene the difficulties, which Caſemates haue cauſed to the beſieged, and the ſmall benefit they haue receiued by them, which not withſtanding haue bene made with all the induſtrie that poſſibly might be, thereby to hinder an Ennemie from putting ouer a moate and makeing his batteries vpon the brinke of the moate, to beate downe the flanks, and to diſmount the peeces of ordinance, planted in the ſaid Caſemates, to wit, that beſides the expence, the gorges are made by this meanes leſſer, the Orillon or pillow being noe more

then

then the ⅓ of the flanck, and is of litle reſiſtance, and on the other ſide giues but litle advantage, being ſoone ſtopt, as we haue ſeene in time paſt : I was minded not to haue ſpoken of them at all, though I eſteeme them good, if they were made in ſuch a ſort, that there mouths might not be ſtopped vp , and the peeces within them diſmounted: which hath not bene done hitherto to my remembrance. For if theſe Caſemates be made of brick batts, when the Beſiegers ſhall play vpon them with there ordinance, the bricks flying into the port-holes will doe more hurt to the Canoniers, and other men, then the Ennemies bullets themſelues, and by this meanes the portholes wilbe eaſely filled , and ſtopped vp , as wee haue ſeene in diverſe places. If your Caſemate be made of Earth, ye muſt giue it a great Talude (that is much ſlooping) which maketh the gorge ſo narrow, namely in thoſe Fortreſſes, which are vnder an *Hexagone*, that oftentimes there wilbe hardly any entrance into the bulwark, which we call the gullet, the Orillon, and the flanke very litle , and conſequently wilbe of litle reſiſtance, wherein they finde ſo many difficulties, that many great Captaines haue reſolued wholly, to leaue them vnmade. If one could not preſerue them otherwiſe then they haue done to this preſent : I ſhould approue of them: But ſeing I cannot reſolue of a thing, which I dare not wholly approue off, becauſe experience, and many men ſlaine in the warres haue not found it good, this is my opinion alſo. In the Figures 157, & 158, of the Plate 37, a, b, is the vtmoſt end of the ſhoulder, the double of p, a, Figure 157, the mouth, or port-hole of the Caſemate, and as b, p, maketh 150, foote, ſo p, a, will make 50 foote, p, t, equall to p, a, wilbe likewiſe 50 foote, t, v, is 36 foote, from *a* ye ſhall draw a line to *u*, that ye maye the better diſcouver the exteriour brinke of the moate, and the ſaid t, u, ſhall containe three portholes for three peeces of Canon, which ſhalbe vauted ouer from d, e, to, t, u, with ſteps as the Figure 158 demonſtrats, marked betweene t, v, and e, d, in ſuch ſort that the firſt Vaule on the ſide of e, d, is cloſſe by the ſuperficies of the water enlarging or raiſing the ſaid Vaults more and more, vntill that the laſt vault towards t, v, be raiſed aboue the ſuperficies l, f, g, k, which is the plateforme of the Caſemate, ſome 3 foote, or thereabouts, and ſeing that t, e, & d, v, are about 20 foote, ye ſhall advance as farre as poſſibly ye can the parapet t, f, and g, v, as much as the canon, and the place will permit you, to giue the better ſoliditie & firmeneſſe to the parapet of the Caſemates. Then vpon the topp of the baſis f, g, e, d, the ſaid parapet ſhalbe ſo raiſed that the inſide f, g, ſhalbe lined with a wall, that it maye prevent the falling downe of ſuch a heigth, & ſo that the ennemie maye not diſcover the vpper part of your vault, h, i, k, l, and firmely joyned aſvvel to the wall, as to the Orillon and on the outſide with hard Earth, as ſtrong as poſſibly maye, going downe ſloopingly, that it maye not be ſubject to tumble downe into the moate , and this will hinder the Ennemie greatly from entring into the moate and putting his gallerie ouer. For by this meanes they muſt be driuen firſt to beate downe the ſhoulder, and make it to fall into the moate at the ſpace p, a, e, d, which for this reaſon muſt be made as deepe , as poſſibly ye can, to the end, that the portholes 3, 4, & 5, be not eaſely ſtopt, the place l, k, f, g, is about 20 foote vncovered, and the vault i, h, l, k, alſo 20 foote broade. The line h, i, is about ſome 54, foote: the Colomne is made in the midſt of l, k, to make the vaults croſſwiſe: becauſe the diſtance betweene l, k, is too great, to make there a ſingle vault , which maye ſerue to make vpon it the parapet of the ſuperiour place , to gayne more place for the gorge, and to lodge the Canoniers, and there amunition dry,

The entrance into the *Caſemate* muſt be in that place, where m, n, is, vnder the rampart, and muſt be vaulted from m, to i, & from n, to o, being ſome 10 or 12 foote broad, or thereabouts, that ye maye the better draw in your ordinance & all what

ye haue neede of into the Caſemate, and make it as high as neceſſity requires: The orillon a,v,y,b, is al together maſſie, that it maye giue the greater reſiſtance. And becauſe ye maye the better vnderſtand our intention, we haue added herevnto the Figure 158, which raiſed worke is repreſented in perſpectiue: in which ye may ſee the parapet of the falſe bray, the port-holes of the Caſemate, and other things, which we haue thought neceſſarie to make knowne.

The 38, Plate & 160, Figure.

A Fortreſſe being thus provided with good falſe-brayes, aſwell vnder the Bulwarkes, as along the curtaines, broad according to our former plots: I could wiſh that a Caſemate weere made in that forme which wee ſhall now deſcribe, and that the curtaines, were drawne in as farre as the bredth of the falſebray with the parapet containes, to wit, that the falſe brayes vnder the Bulwarks might end on the outſide of the foundamentall lines a,b, and the like: and contrariewiſe, that in the curtaines the ſaid falſebrayes maye end within the ſaid fundamentall line c,d, ſo that the ſpace i,f,g, maye be accommodated, as the Figure 160, repreſenteth, to plant therein two peeces of ordinance, which will worke noe ſmall effect: & by this meanes the Caſemates, wilbe better preſerued then otherwiſe, becauſe ye neede not feare the flying of brick-batts about your eares, ſeing that the flanck e, will ſerue as a ſtay and a covert therevnto: ſo that in ſtead of one ſhoulder ye ſhall haue two, to wit, b,p, and c,e.

The deſcent into the falſe-bray, which goes round about the Bulwarke ought to be made at m, and to come out at y, and ſeing one makes ſometimes ſome privie ſallies, betweene A and p, one might alſo make the entrance into the Caſemate in this place, makeing a vault from m, to y, to wit, in the vnderpart of the Caſemate: The entrance into the falſe bray from the curtaine ought to be made at w, from one & the other part. The letters q,r,ſ,t,v, repreſents the place where I would maks Catts, if one reſolues to make them: but ſeing I am not reſolved about this point, I will rather ſpeake nothing thereof at this preſent.

Figure 2. 160. & 38. Plate.

IF the Bulwarke be not maſſie, but hollow, ye maye make your entrance into the Caſemate, as here towards o. r. p. l. z. and the entrance into it ſhould be at the point, l. all the ſpace l. z. p. r. o. being open.

Of Braſſe ordinance.

The 39. & 40. Plates and 161. 162. 163. 164. Figures.

WE were minded to haue treated of diverſe other dependances belonging to fortificatiõ, as of bridges, gates, ports, foundations &c. how townes & publick places ought to be fortified. but the Printer not willing to ſtay any longer for the finiſhing of this booke, it is not poſſible for me to effect my intention, ſo that my project alſo touching the caſting of braſſe ordinãce is for this reaſõ alſo fruſtrated, having bene minded to haue deſcribed the proportion. aſwell of their carriages as of their charges, and other dependances about them. To which end I had ordayned theſe 4 braſſe peeces which are vſually caſt in the vnited provinces, according to the ſcale herevnto annexed: whereof the leaſt carries a bullett of 6 pound weight with the Figure noted 161: the ſecond is the Figure 162 & carries a bullet of 12 pound

weight

weight, the third 163 carries a bullett of 24 pound, and the fourth marked with the Figure 164. carries a bullet of 48 pound, of the two last, the first is a halfe Canon, and the last a vvhole canon, or peeces for batterie: the two others are field-peeces, bearing a bullet of 6, and 12 pound. In the meane while, he that desires to know the proportions of them maye make vse of this scale, till we vvrite more at large thereof.

ALBERT GIRARD.

Before vve come to describe the tvvo tables, vvhereof vve haue made mention before, supputed of a nevv: vvee vvil explaine some termes, vvhich vve haue introduced, because they vvere nameless before. To that end vve vvil take one of the Figures of the eleventh Plate excepting the last vvhich is the 68, and the line N C being dravvne, vvhich vve vvill terme the gullet (to distinguish it from N A, or A C, the gorges) vvhich comes to cutt through the Capitall, *being dravvne further vvithin the Figure, in a point, vvhere the letter Z, is made, then E, Z shalbe called (*the extention*) that is the lengthned capitall, for the Bulvvarks extends so farre outvvard. Then the angle G, A, C, (*the forme-flanck*). Also in the 60, or 61, Figure E L, shalbe called* the Raid majour, *and L A,* the Raid minour, *finally, in the sixth Plate, the line D, F, or K, L, is called* the surface *as being placed before the face (for* surface *is a vvord not much vsed, and as* superficies *signifies all one thing: ye must not thinke that the second table is calculated amisse; because the progression of the second flanks doe encrease, euen to that of the* Heptagone, *and then diminisheth: for if one should continevv the table from the one end to the other, it vvould followv, that the angles of a* Polygone, *should be* equidistant 130, *degrees (vvhich vvell nigh containes* the second flanke majour 8.412*) & so haue the second flanks equal. vve vnderstand* equidistants *the one so much more then* 130, *as the other lesse. Likevvise* the defense flancking, *diminisheth even to a* Pentagone *& then augmenteth. The least that vve can observe is, vvhere the angle of the* Polygone *is* 113, *degrees, to vvit, of* 53, 366, *& the* Equidistant *are equal. One maye say the like of the first table, vvhich decreaseth to* 48 *rod, and aftervvard encreaseth. The fortification of a right line holding not vvith the one or the other table, is placed betvveene them both. Those that vvill make vse of them proportionally, for the building of* irregular *Figures commits noe small errours, though* Marolois *vvas of this opinion, and so much the more, because the angles of the* Polygone *are about the right angles, for the other* Polygones *differ alvvaies lesse one frõ an other, the further they fall from the* quadrate: *so that vve to this end, if vve vvere vvilling to make vse of them, the tables vvhereof the angles of the Polygones are progressiue of* 3, *or* 4, *degrees of space, vvould be of a better choise, & should here take place if time vvould permit vs. Let there be here some small exemple thereof, and suppose, that one vvould fortifie an angle of* 99, *degrees, vvhereof the tvvo sides are each of them* 36 *rod, and* 3 *primes, & take* a Pentagone, *or* a quadrate *to imitate, and let vs take* a quadrate *by vvhich meanes, he shall finde the lines as they are herevnto annexed: vvhich done, let vs take the* 7, *Figure of the second Plate: to speake more intelligibly thereof let vs demaund of him, hovv much the angle C B E vvilbe.*

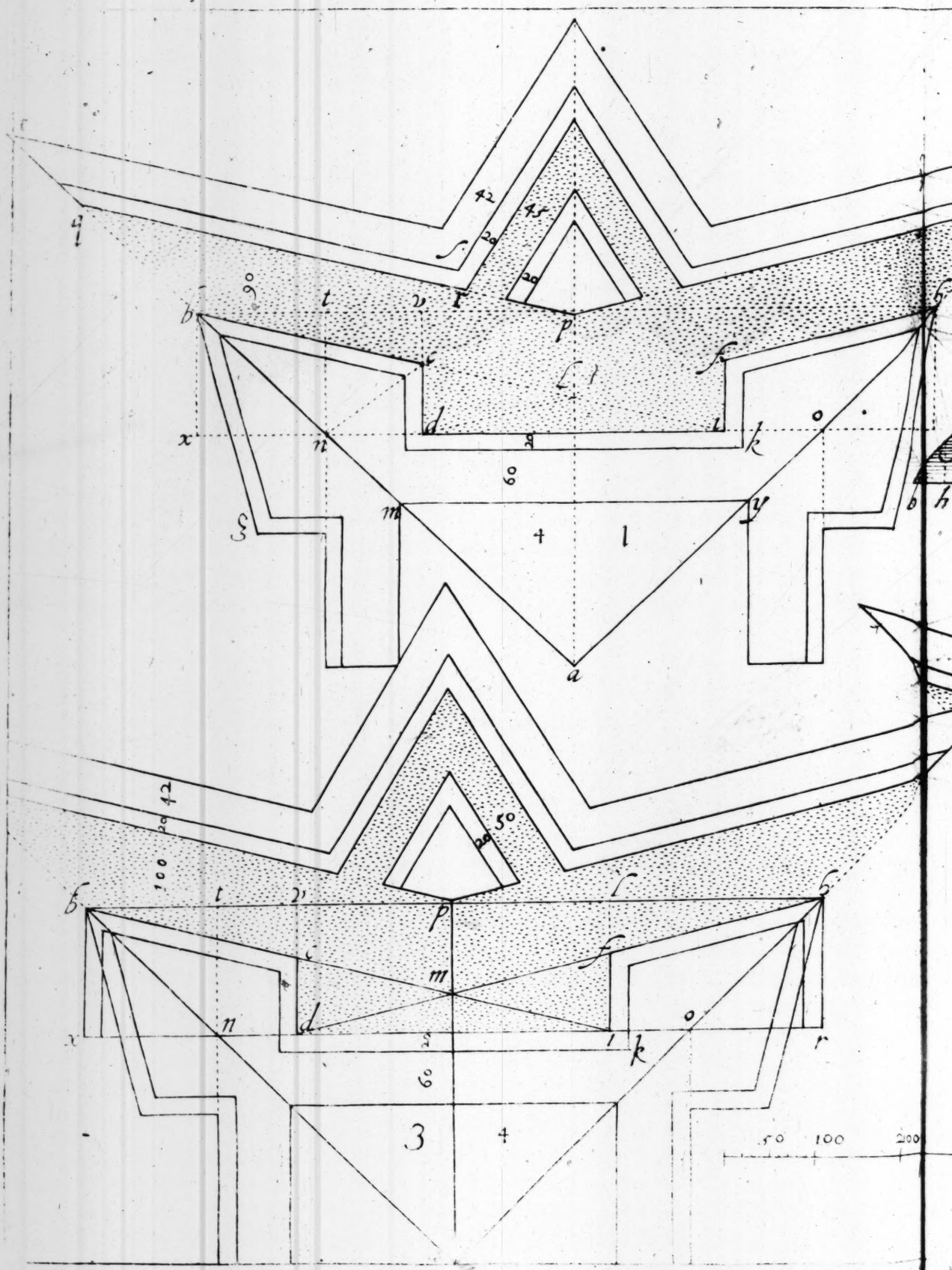
B F	Capitall	13,15	Angles required		Angles of a quadrate
B E	The face	16,00	F B E	32 deg. 15. min.	30 degrees
E D	The flank	5,16	B F D	130. 30	135.
D F	The gorge	6,15	E D F	90.	90.
B A	Defen. Flanc.	33,94			

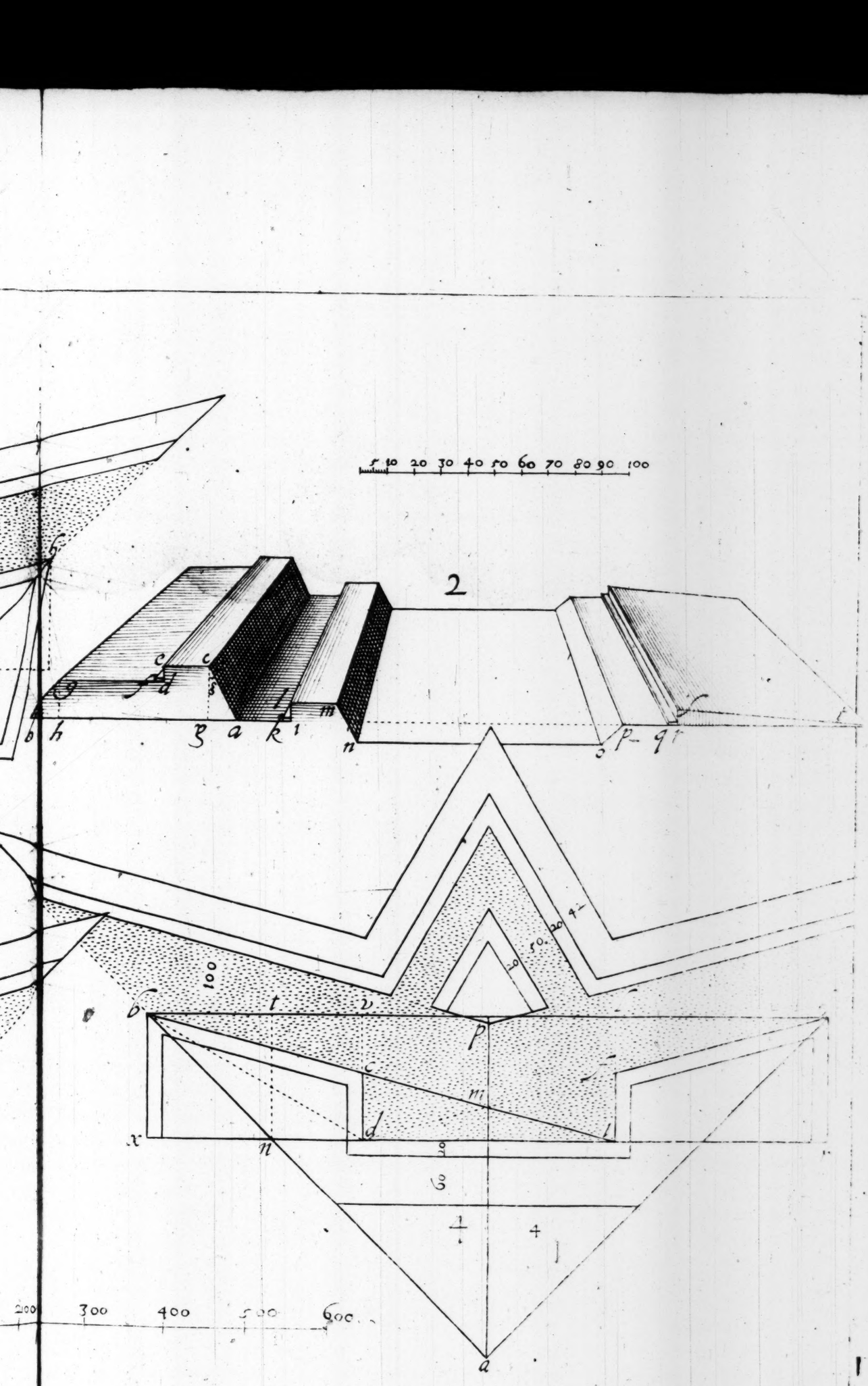
He vvill say, that to the halfe of 99 *he hath added* 15, *and the summe is for the said angle C, B, E, and that the angle B, F, D, is adjunct of the halfe of* 99, *to vvit,* 130, 30, *aftervvard he can-*

not

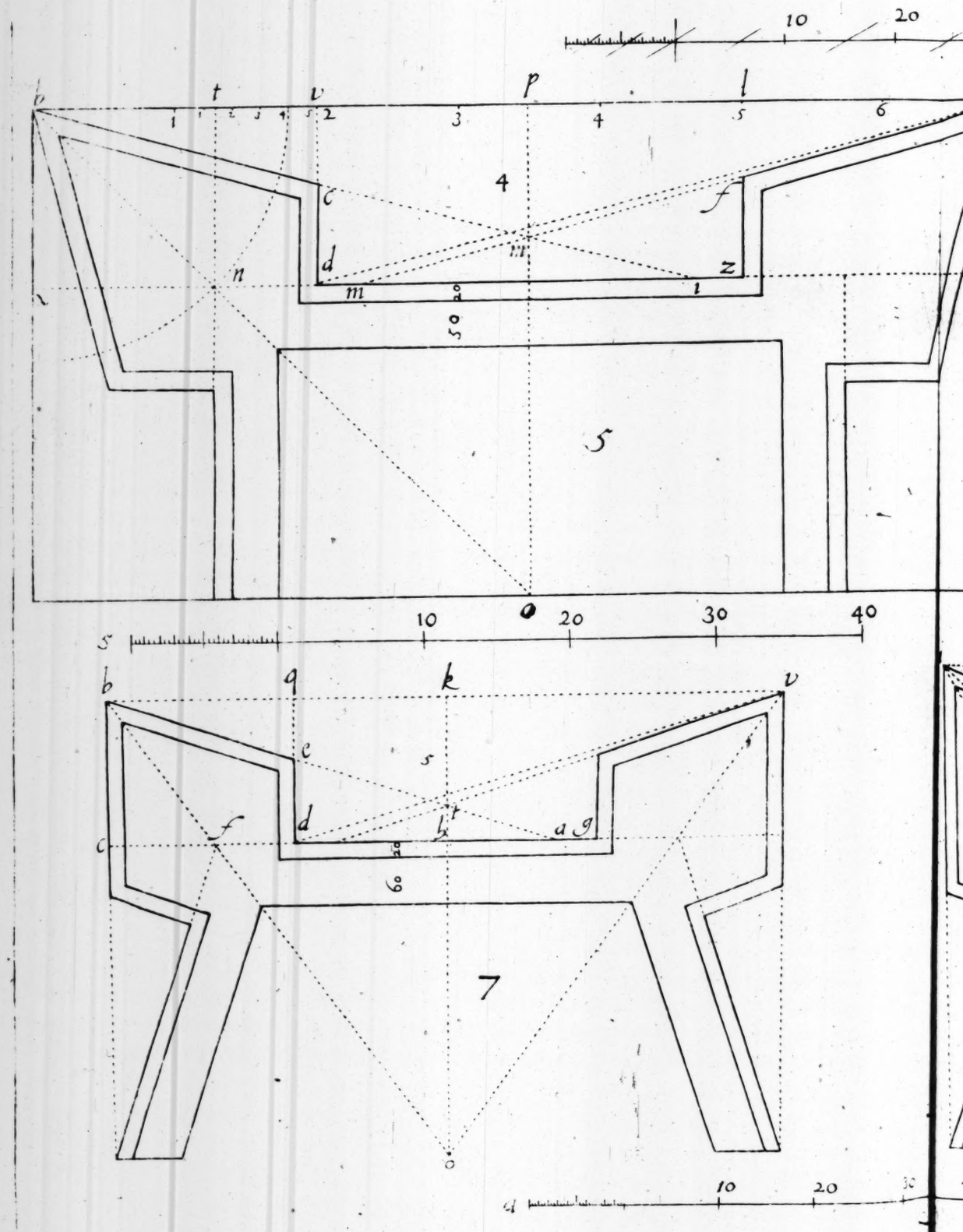
not denie, but the number of lines , vvhich he hath found maye receiue the angles of the ſquare-Bulvvarks halued as there annexed: for the lines are dravvne proportionally from thence: as then the conſequence vvilbe abſurd, ſeing that the quadrangle, *having the foure lines knovvn & D the right, vvhich are 5 common termes of both ſorts of a* quadrangle *abouesaid: The vnknovvne angles ſhall receiue each of them a certaine number of degrees, as appeareth by our* Trigonometrie, *and not tvvo ſorts of numbers for each angle, ſo that if F, co nes to be 135 degrees as it is, it can neuer make 130, and 30, and ſo of the reſt. Novv of one ſhould take the angles as he requireth it, and the tvvo ſides F D, D E, the other lines vvilbe othervviſe, then he hath calculated them, for in ſtead of 16,00, the face , one ſhall haue 51,04; and in ſtead of its flanking 35,94, ye ſhall finde onely 32, 44, and ſo of the reſt, vvhich is an errour of 3$\frac{1}{2}$ rod, vpon 32, here then are ſmall lines & great faults, vvhat would thoſe be then in great and ſolid fortifications. To conclude, vve vvill propound one queſtion aſvvell to exerciſe thoſe vvhich are addicted therevnto, as for to end this diſcourſe: A ſquare fortreſſe regular hath the face 24 rod, & the curtaine 36, vvith an angle forming the flancke of 40 degrees: vvithout a ſecond flanck : hovv many then vvill the other angles and lines be? The manner to reſolue this, and the ſolution ye ſhall ſee hereafter, vvhen vvee haue made ſome treatie vpon that ſubject , vvith hope ſhortly to bring to light , the reſtauration of* Geometrie, *touching the parts thereof, vvhich haue bene loſt hitherto, vvhereof the Authours are* Euclid, Ariſteus *the elder,* Eratoſthenes, *and* Apolonius Pergeus, *vvith ſome other parts of the mathematiques all according to our vveake povver, by the helpe and grace of God.*

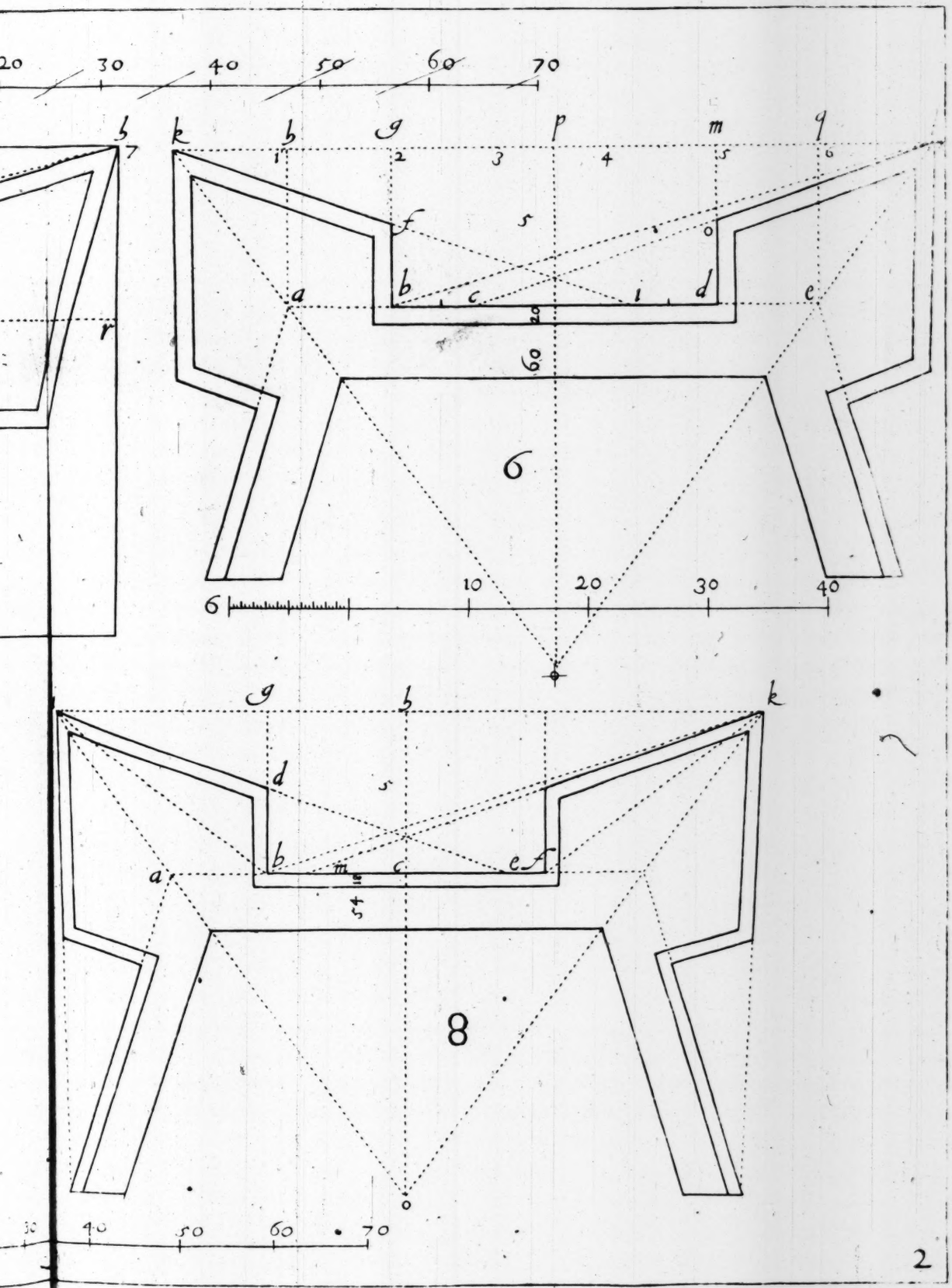
FINIS.


42
45
20
20
90
t
v
r
p
b
c
f
d
l
k
o
x
n
g
60
m
y
ξ
4
1
a
h
42
20
100
50
20
t
v
r
p
b
f
m
n
d
l
k
o
x
60
3
4
50
100
200

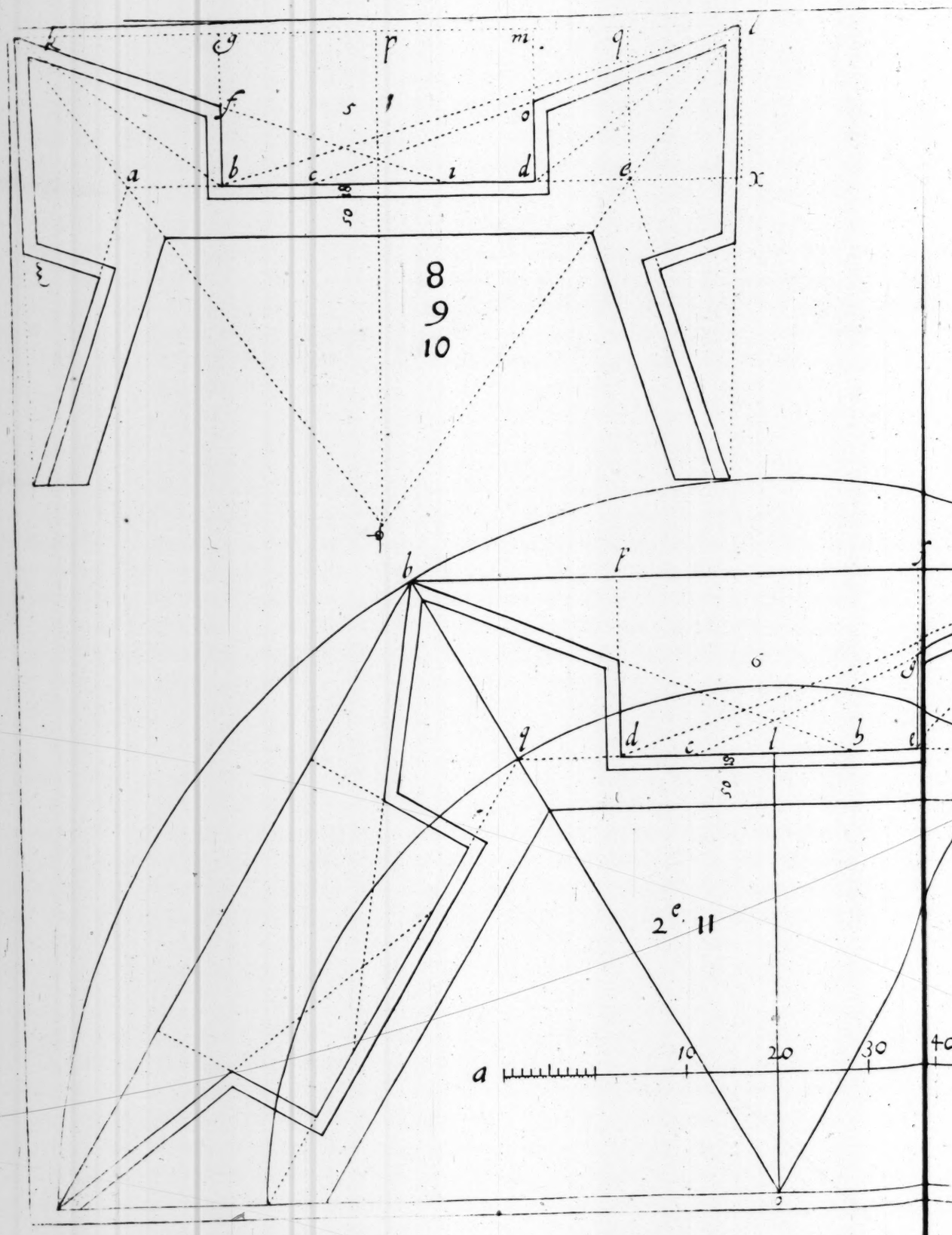

10 20 30 40 50 60 70 80 90 100
2
b
c
d
e
f
m
h
g
a
k
i
n
o
p
q
r
s
100
50
20
10
t
v
x
3
4
200
300
400
500
600
a
1

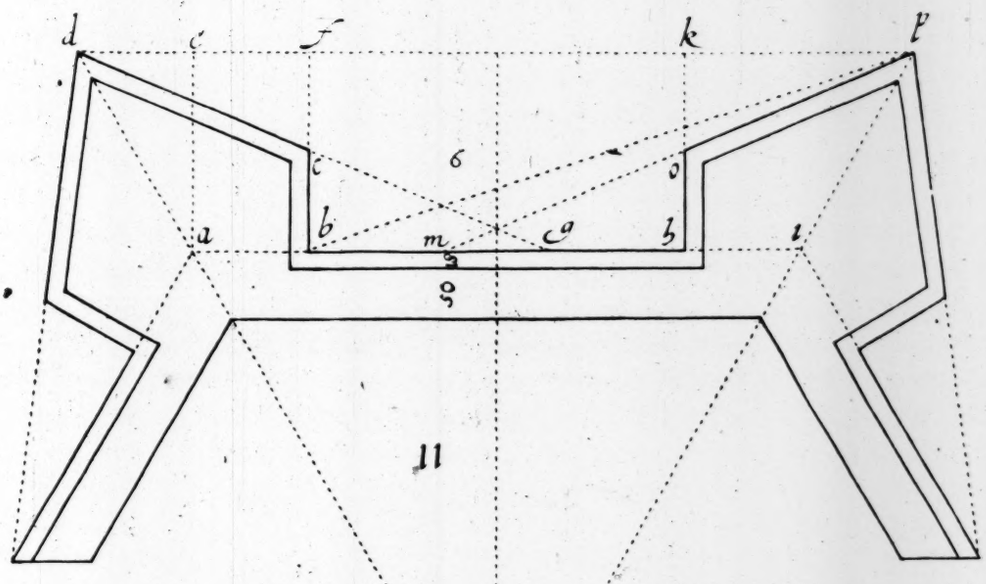
Marolois, S.

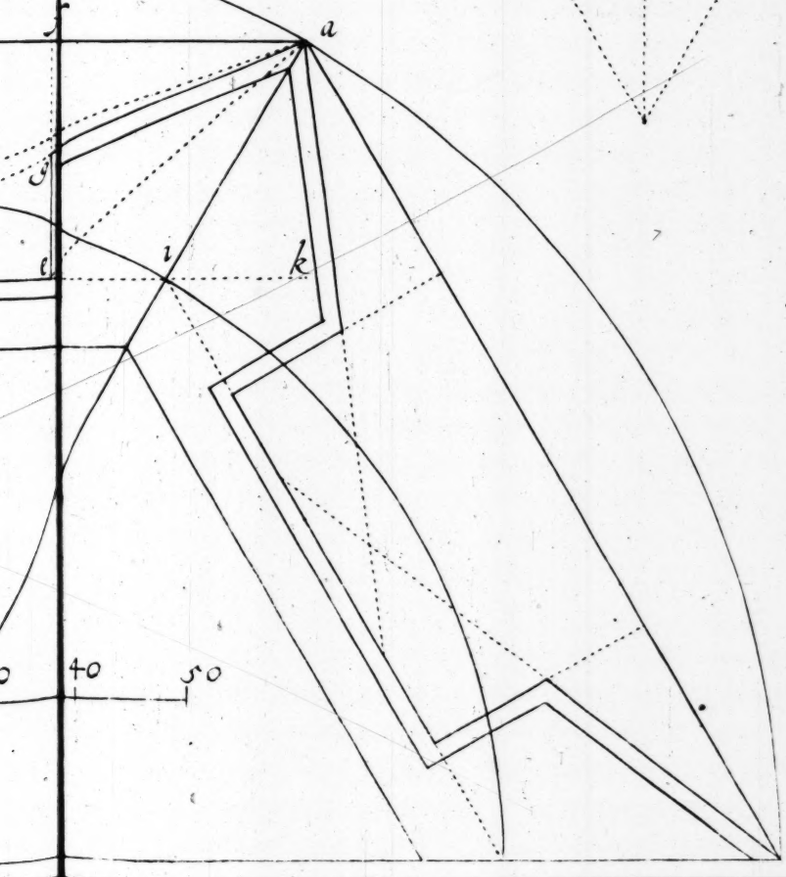

10
20
b
t
v
p
l
1
2
3
4
5
6
4
c
f
d
m
n
z
5
10
20
30
40
5
b
q
k
v
c
s
f
d
a
g
60
7
10
20


20
30
40
50
60
70
k
b
g
p
m
q
1
2
3
4
5
6
f
s
a
b
c
i
d
e
r
6
10
20
30
40
g
b
k
d
b
m
c
e
a
8
40
50
60
70
2

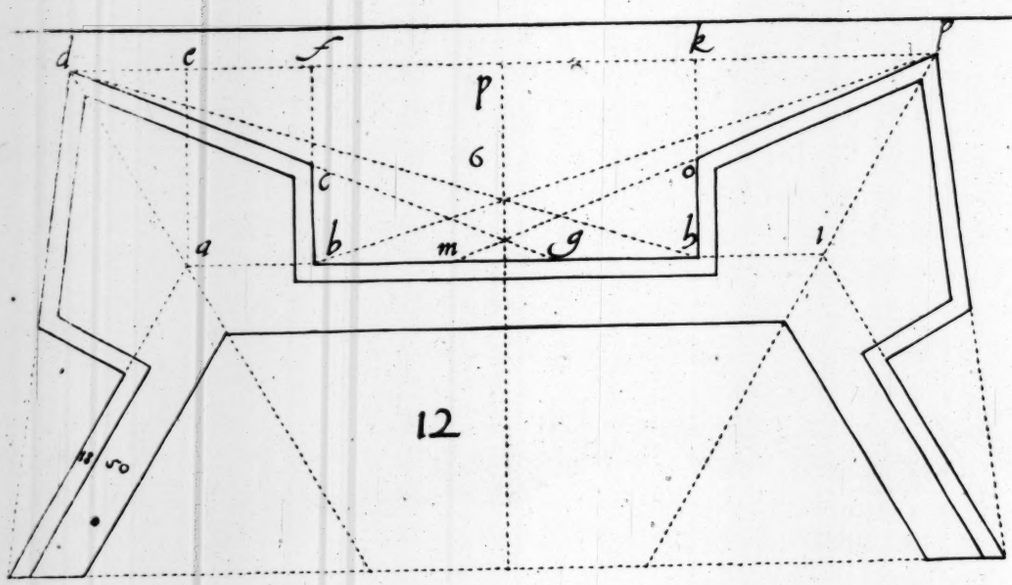
Marolois. S.

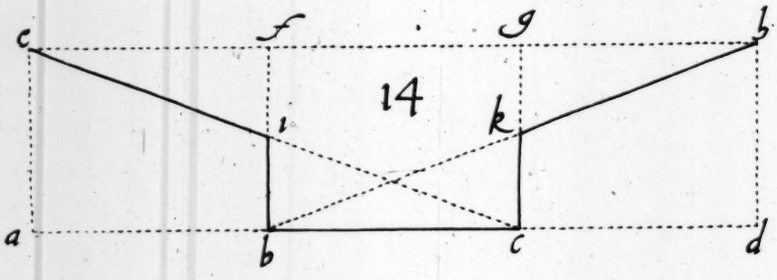

8
9
10
2e 11
a
10
20
30

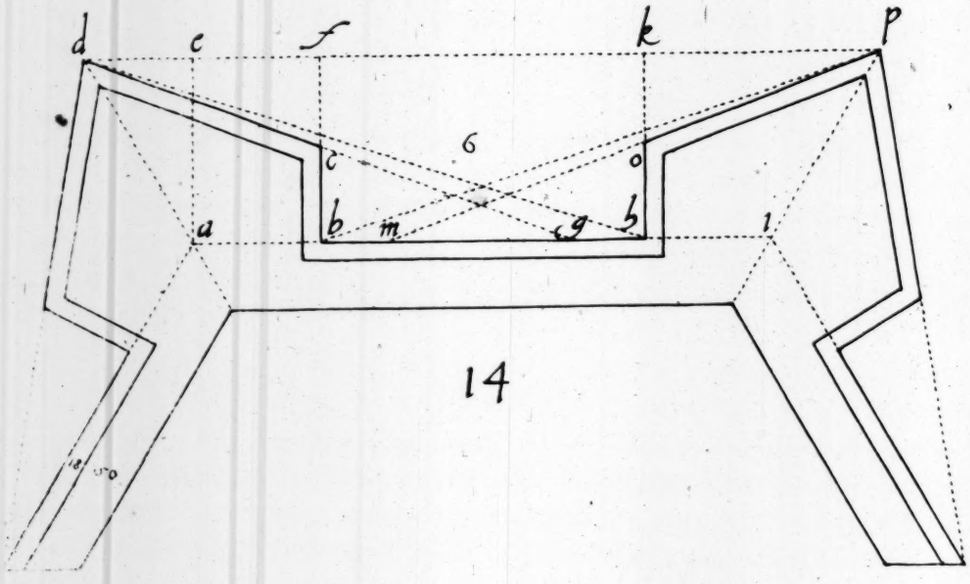


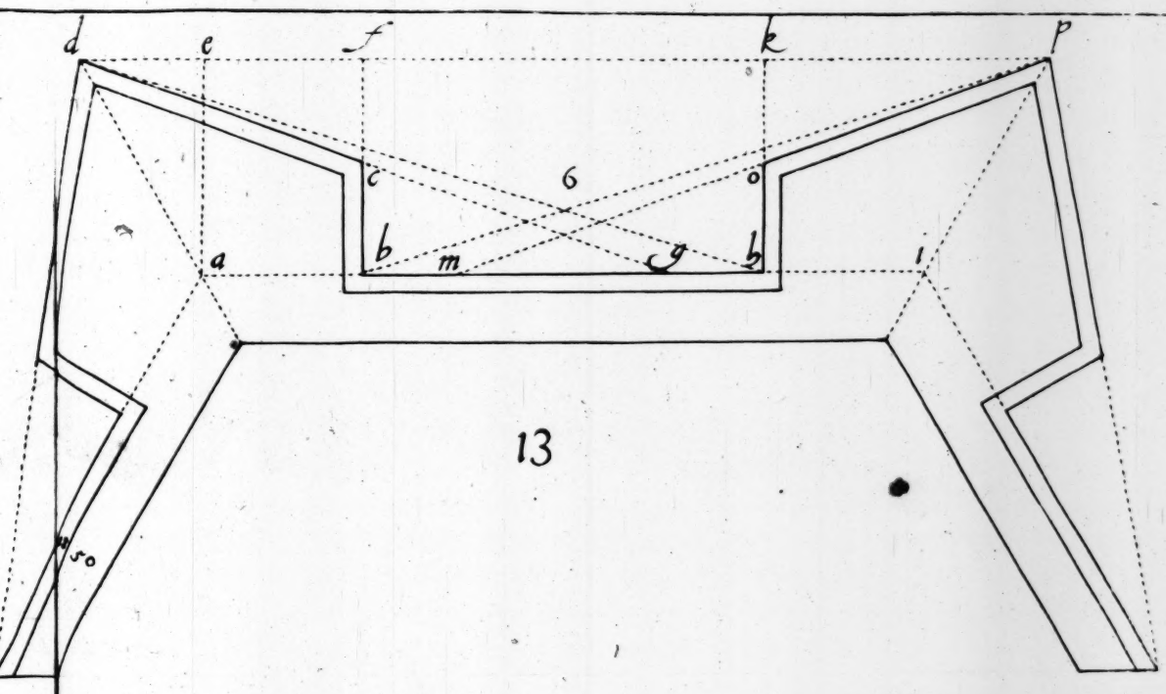


3

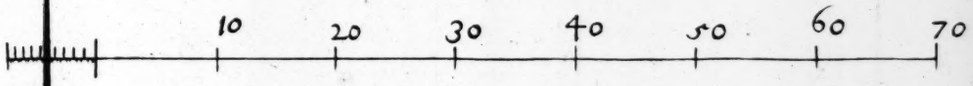

d
c
f
k
p
6
c
o
a
b
m
g
h
i
12

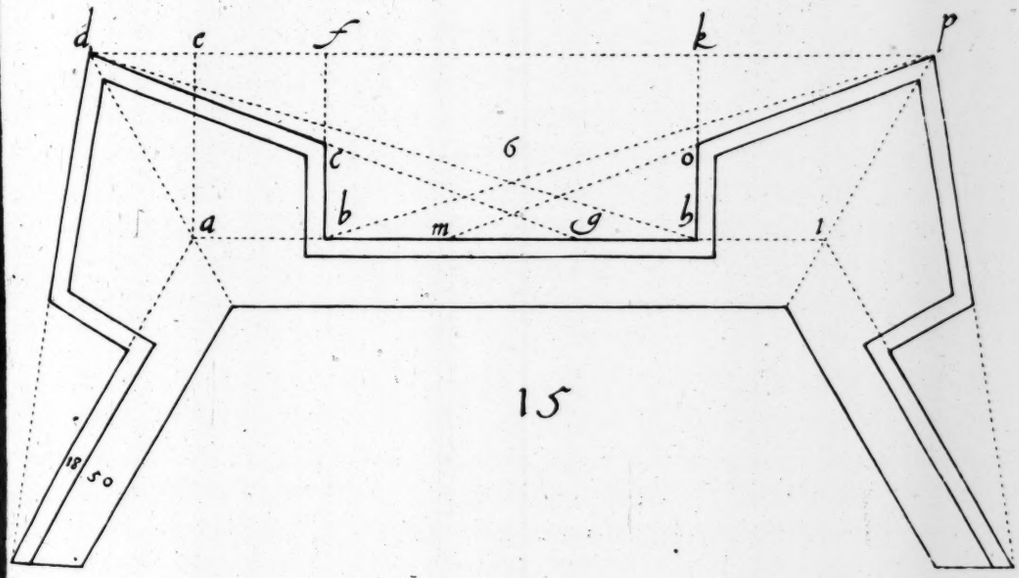

c
f
g
h
14
i
k
a
b
c
d


d
c
f
k
p
6
c
o
a
b
m
g
h
i
14

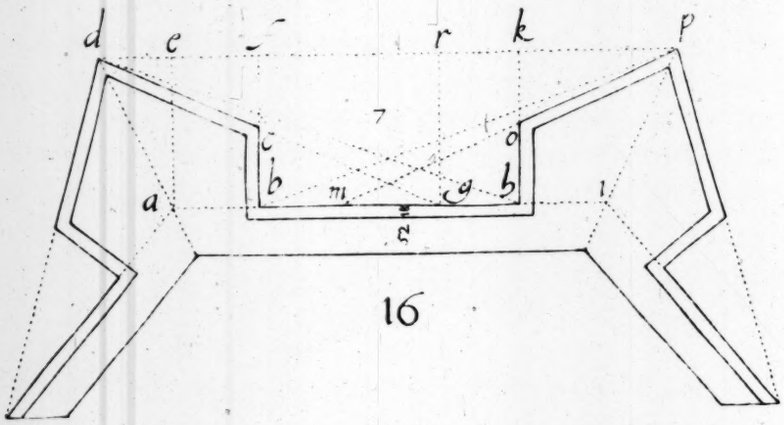


13

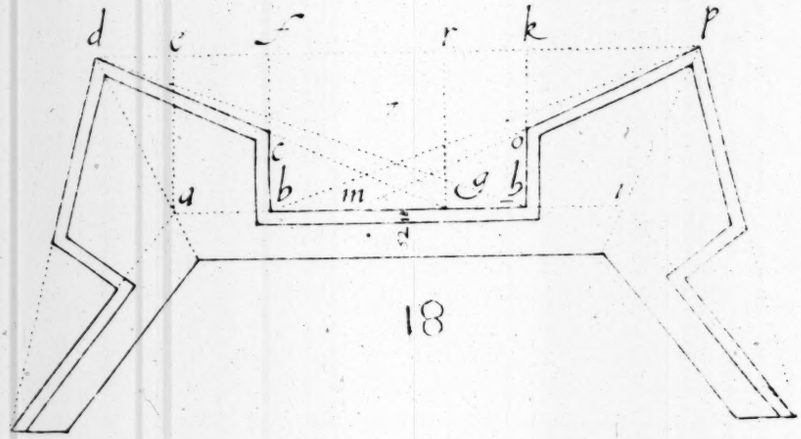




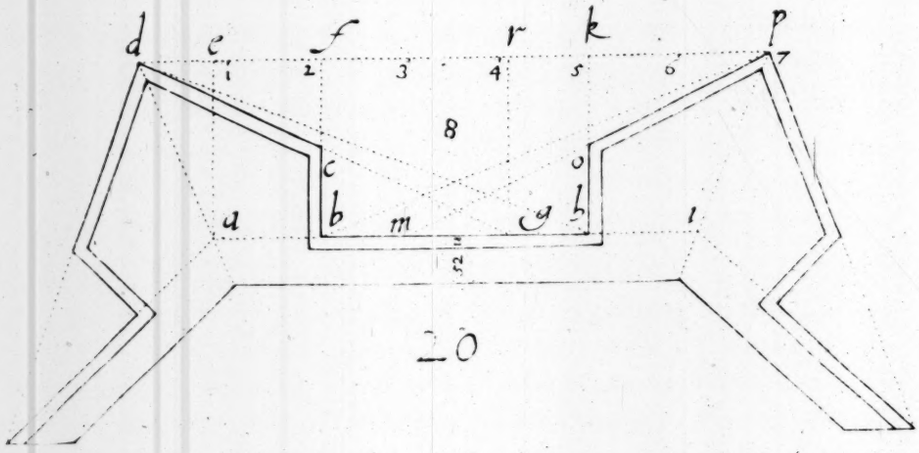
15



16

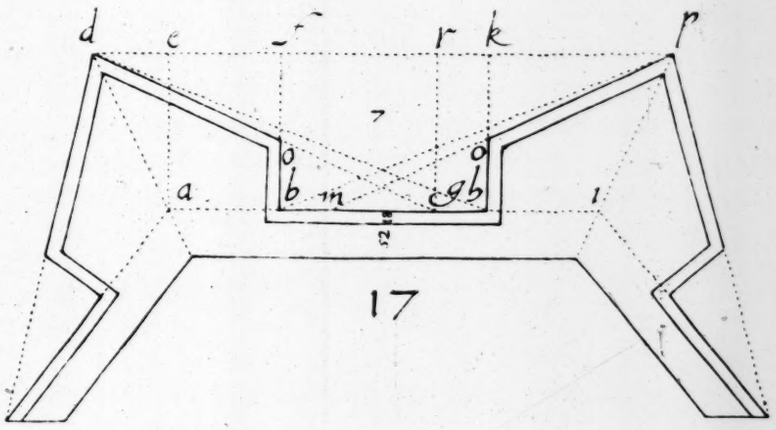


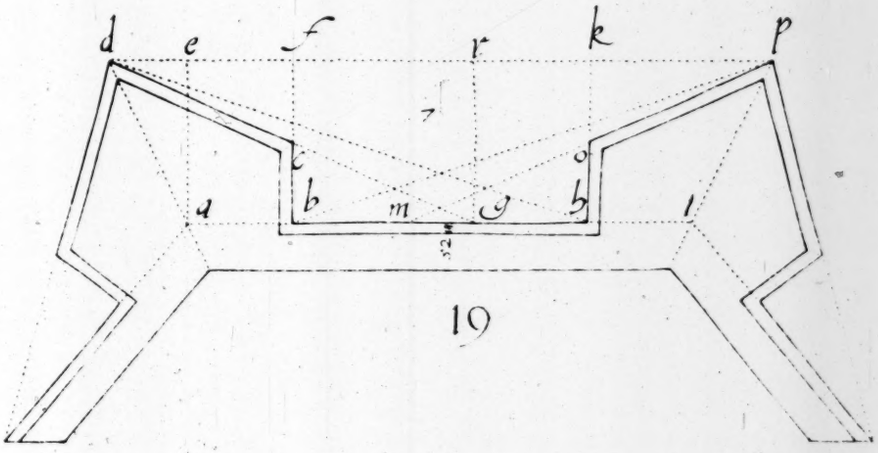
18

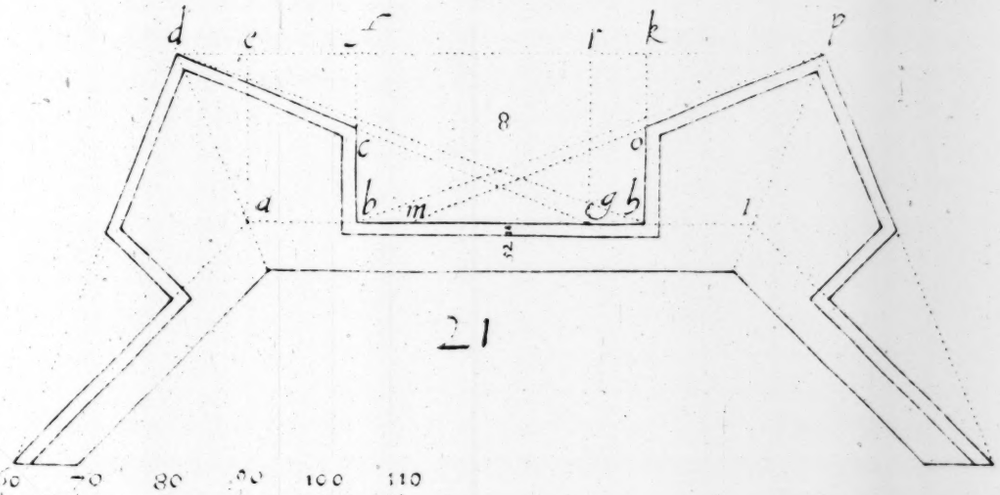


20

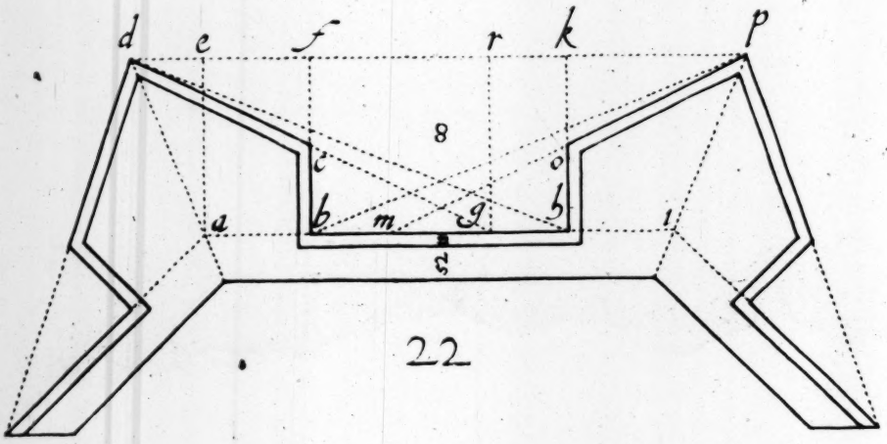
b

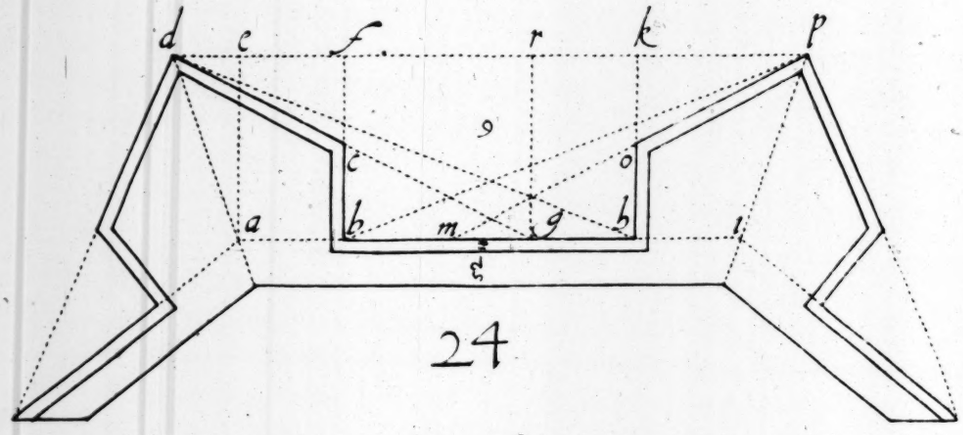


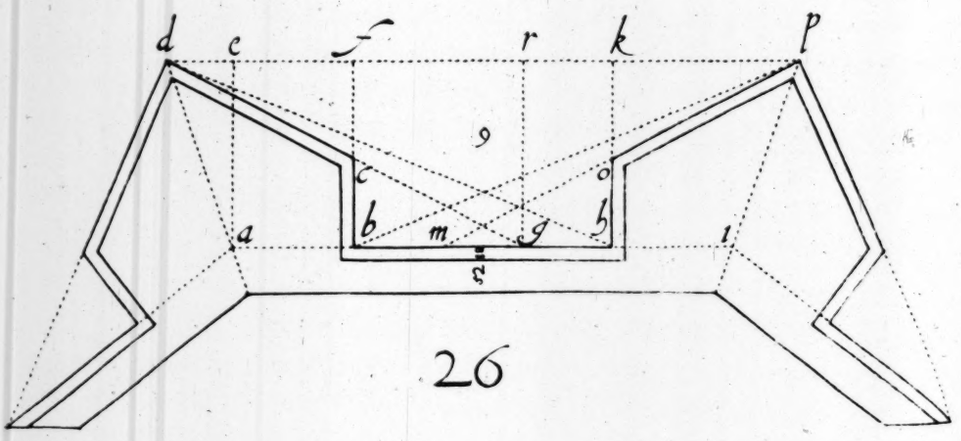




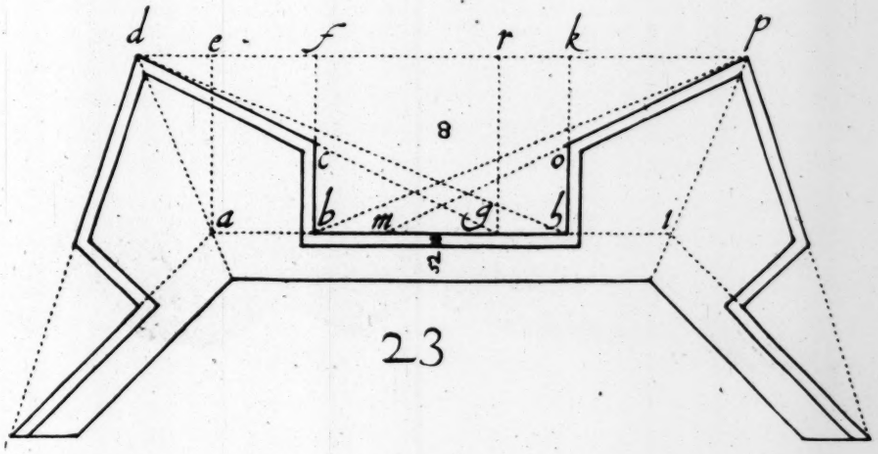
40 60 70 80 90 100 110


d
e
f
r
k
p
8
c
o
a
b
m
g
h
l
22

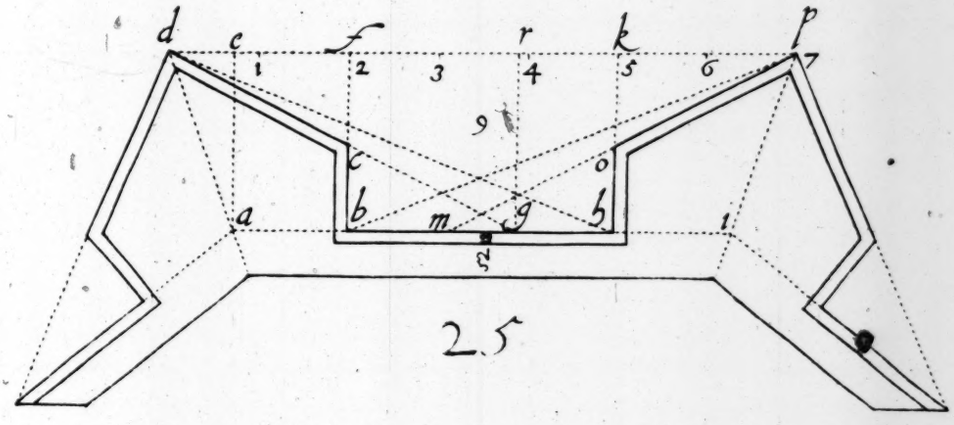

d
e
f
r
k
p
9
c
o
a
b
m
g
h
l
24


d
e
f
r
k
p
9
c
o
a
b
m
g
h
l
26

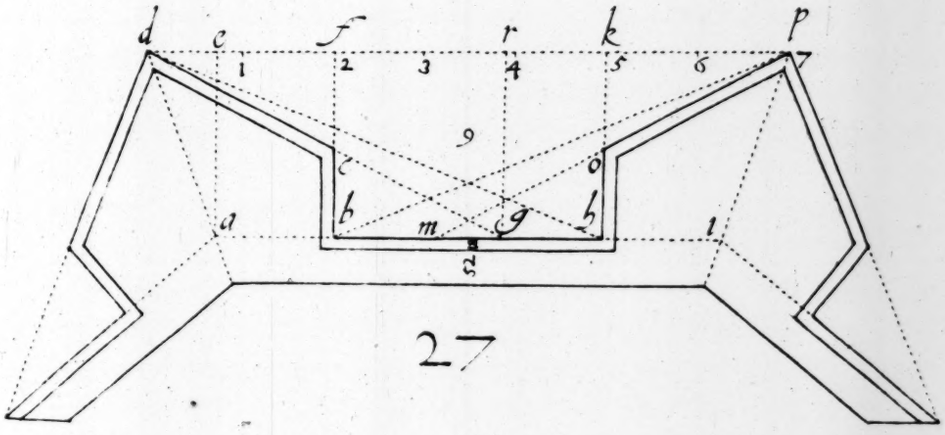
b 10 20 30



23

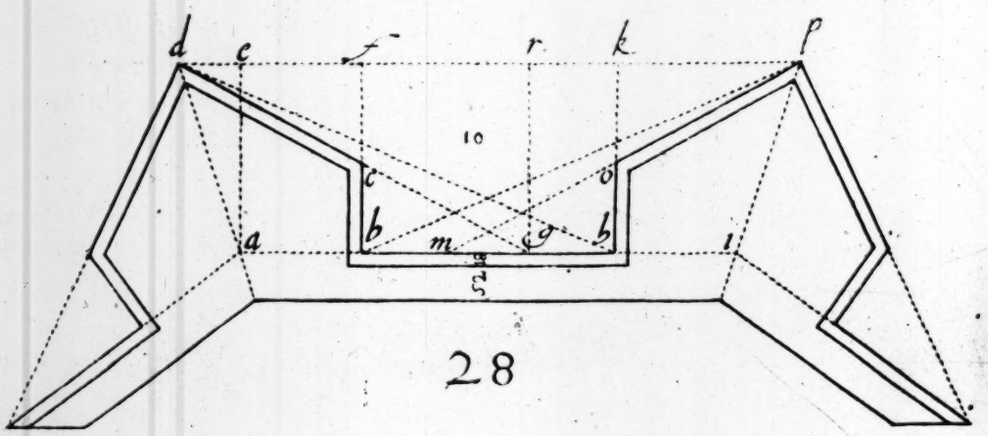


25

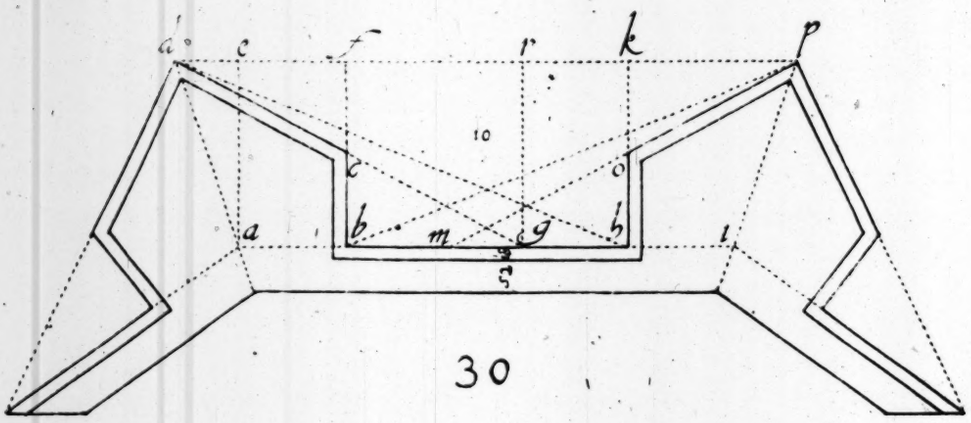


27

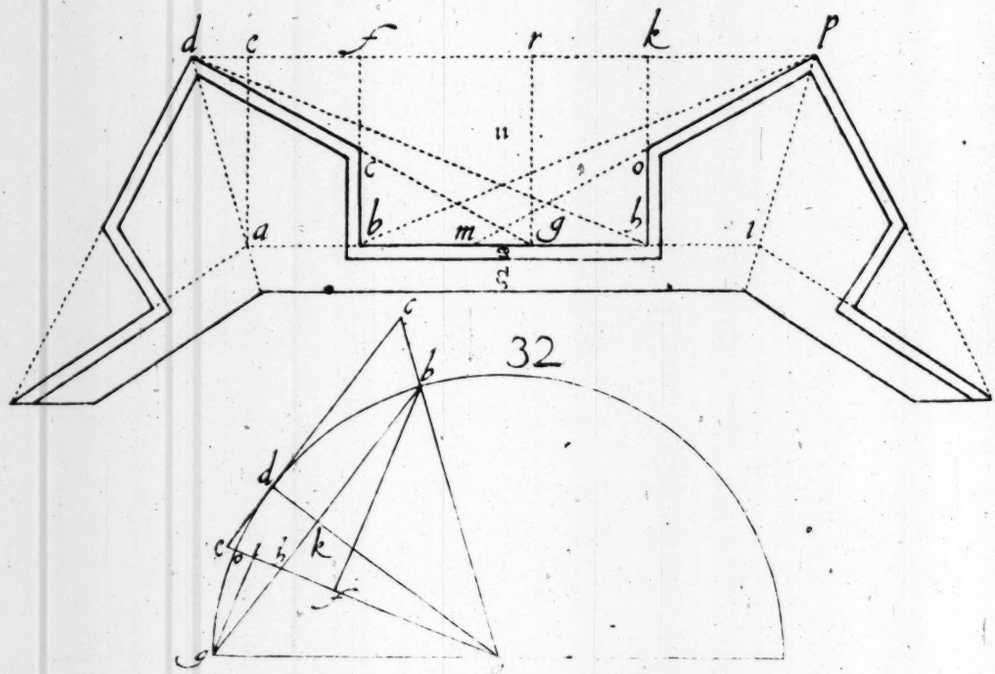
30 50 60 70 80 90 100


d
c
f
r
k
p
10
c
o
a
b
m
g
h
i

28

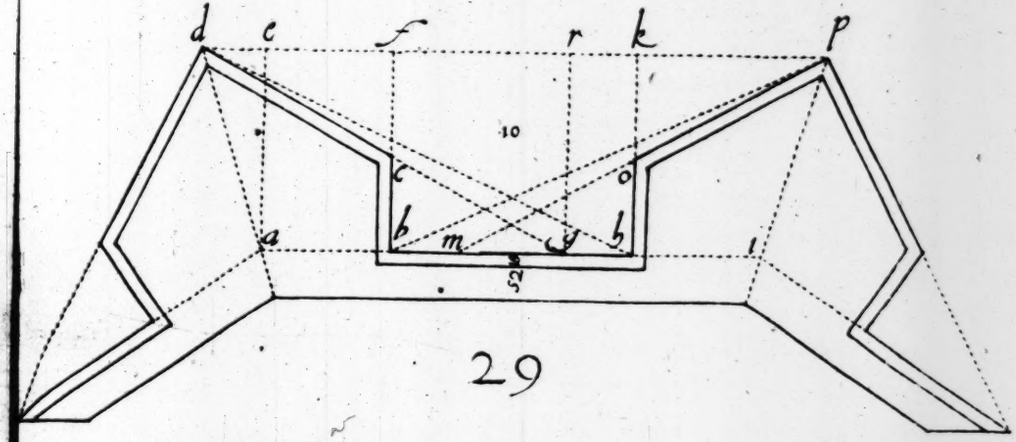

d
c
f
r
k
p
10
c
o
a
b
m
g
h
i

30

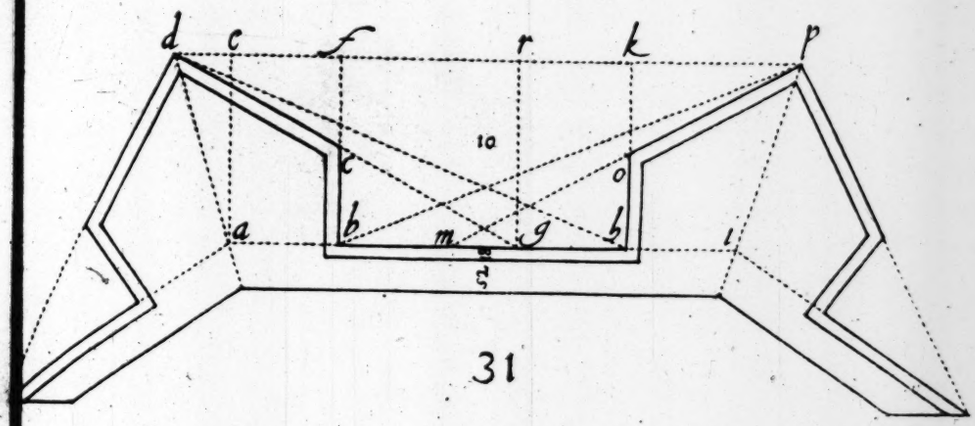

d
c
f
r
k
p
11
c
o
a
b
m
g
h
i

32

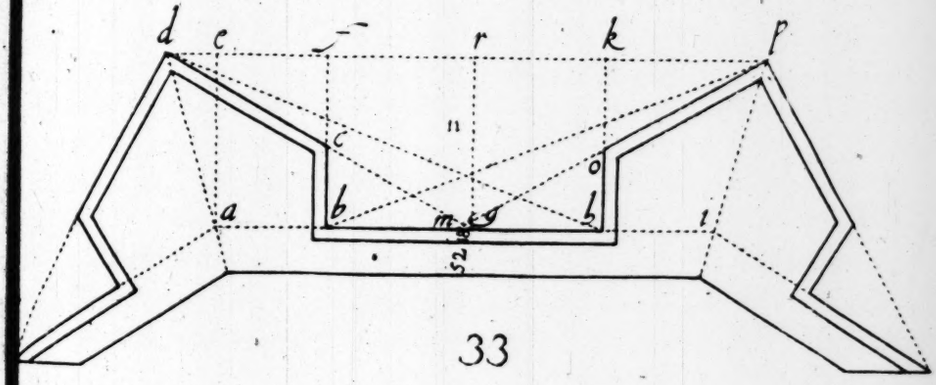
c
b
d
c
o
i
h
k
g


d c f r k p
10
c o
a b m g b i
52

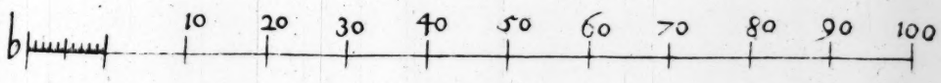
29

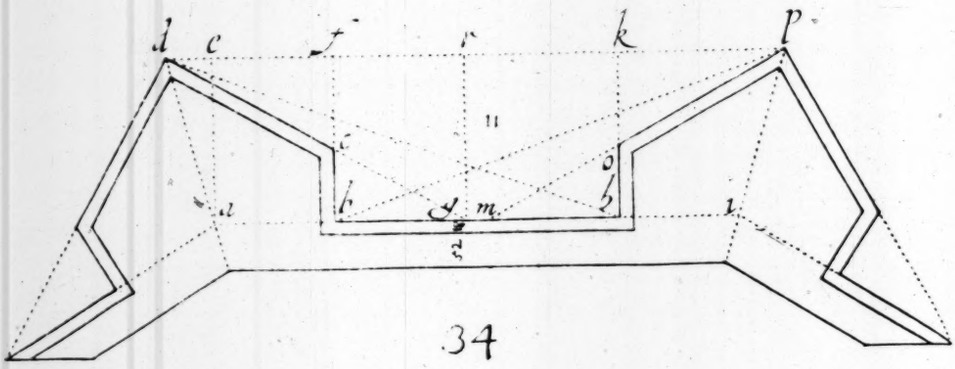

d c f r k p
10
c o
a b m g b i
52

31

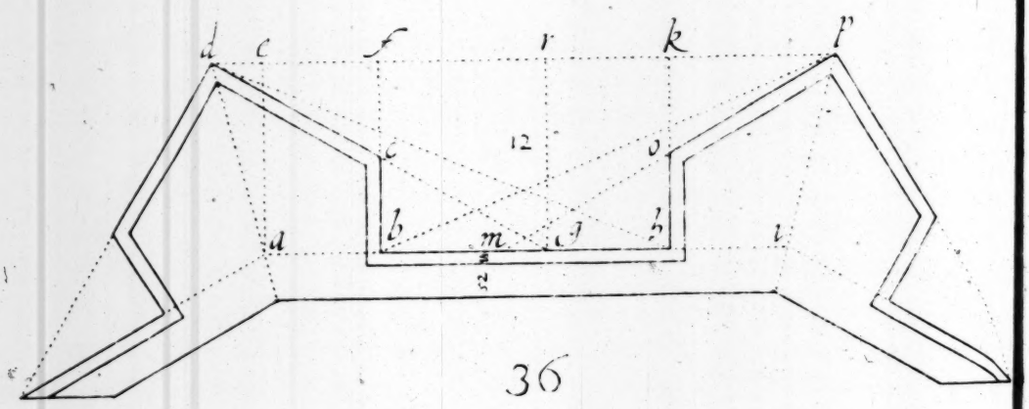

d c f r k p
11
c o
a b m g b i
52

33

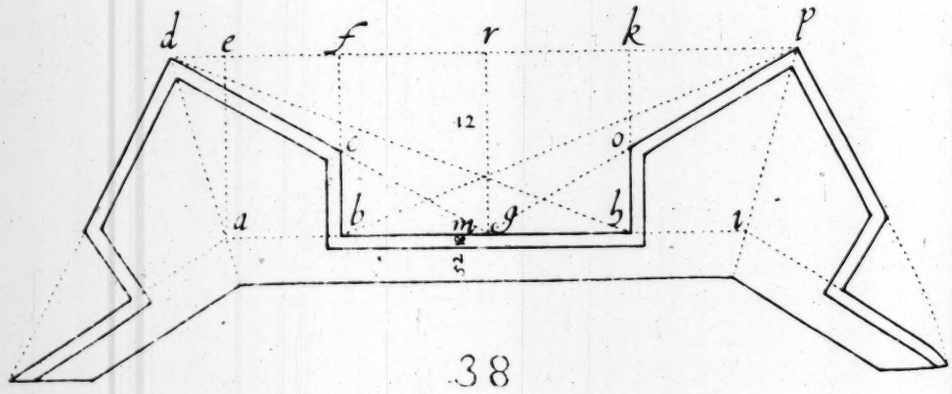

b
10 20 30 40 50 60 70 80 90 100


d
e
f
r
k
p
11
c
o
a
b
g
m
h
i
n

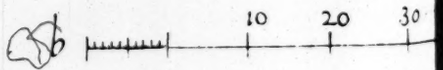
34

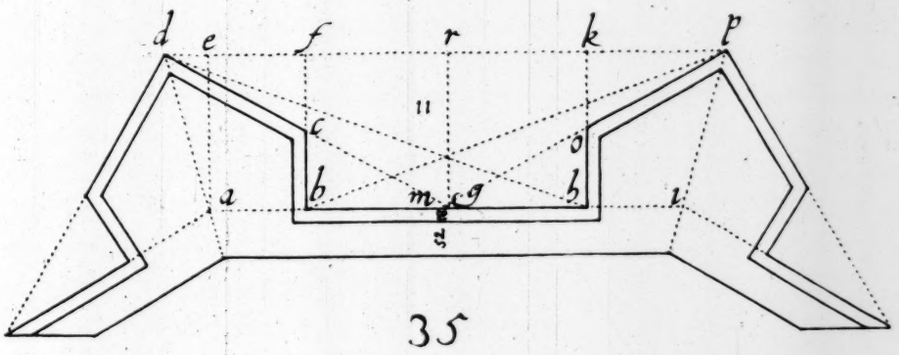

d
c
f
r
k
p
12
c
o
d
b
m
g
h
i
n

36

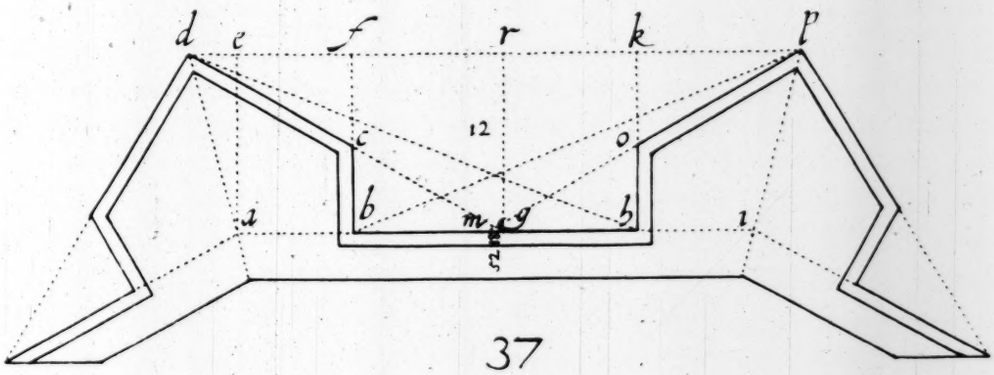

d
e
f
r
k
p
12
c
o
a
b
m
g
h
i
n

38

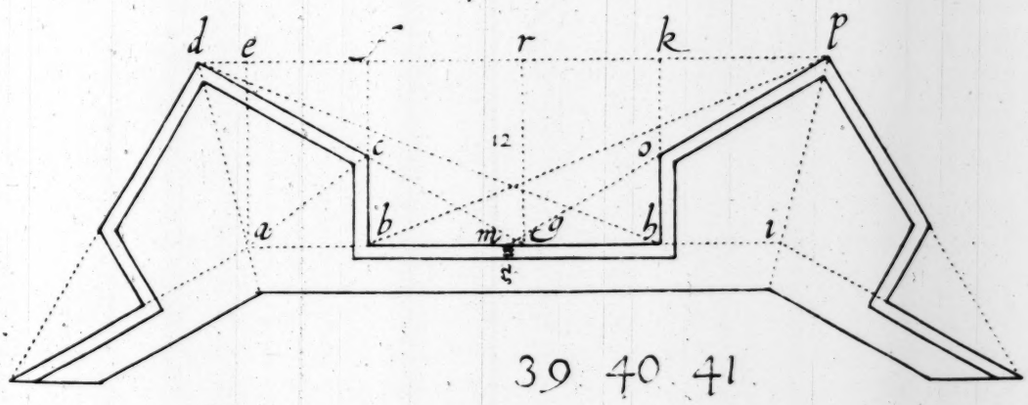

10
20
30



35

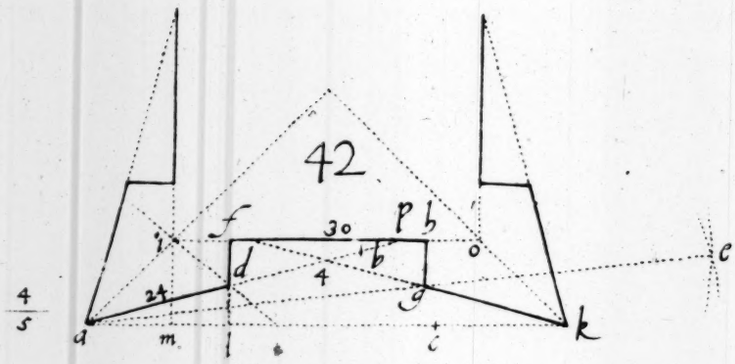


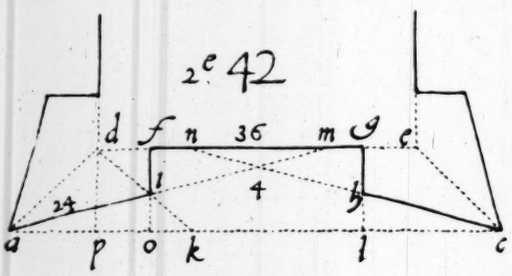
37

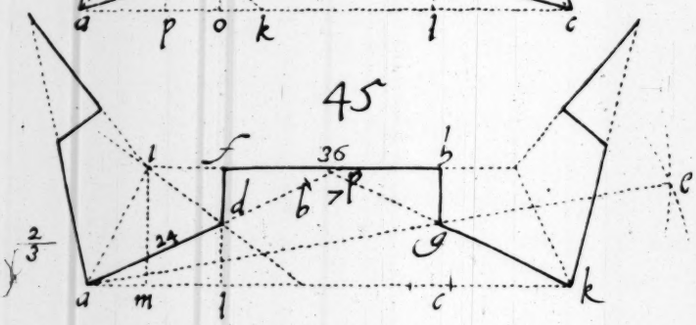


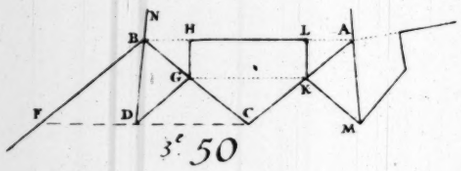
39 40 41

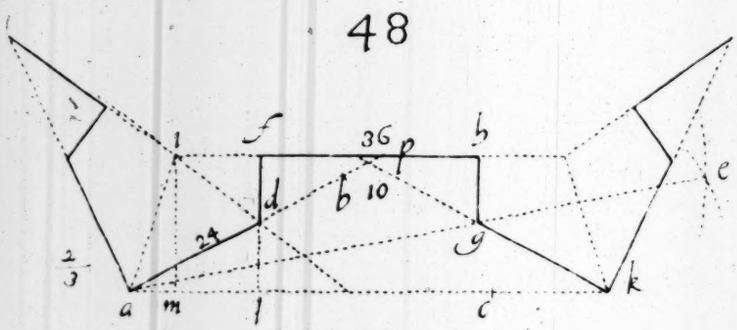
30 40 50 60 70 80 90 100

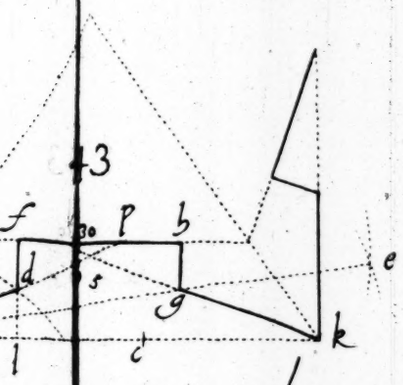

42
4/5
30
24
4

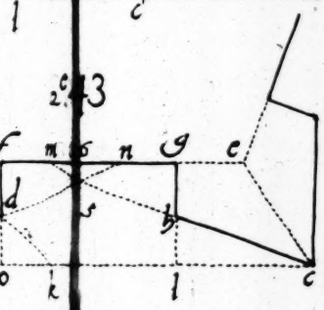

2e 42
2/3
36
24
4

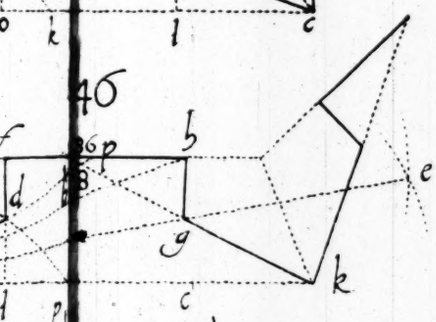

45
2/3
36
24

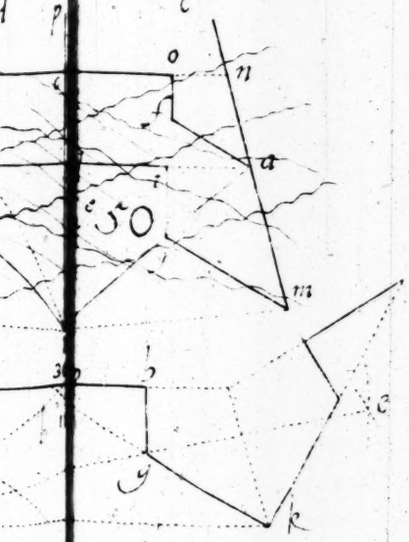

3e 50

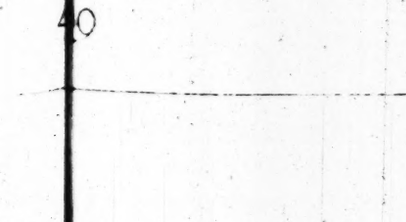

48
2/3
36
24
10

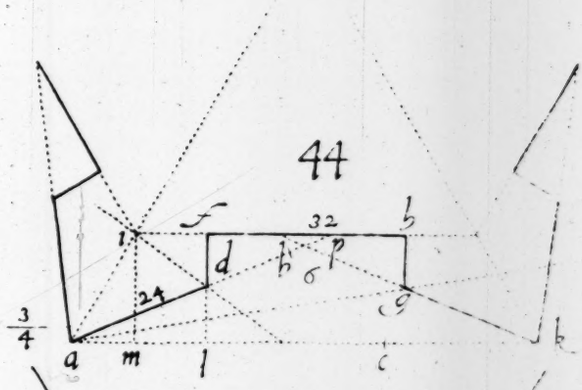

43
f
30
p
b
d
s
g
e
k
l
c

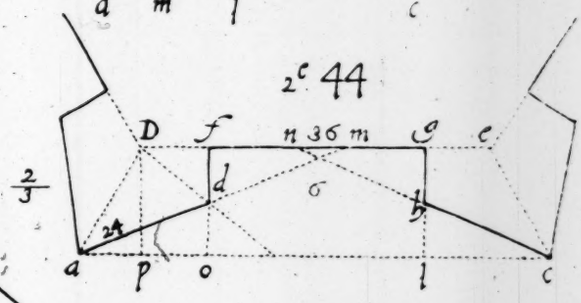

2c 43
f
m
o
n
g
e
d
s
b
o
k
l
c

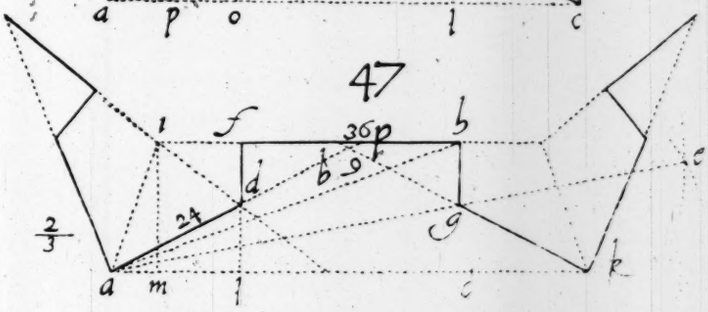

46
f
36p
b
d
g
e
k
c

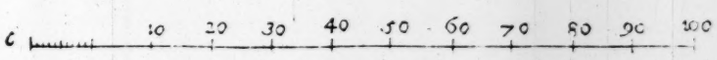

o
n
f
a
c 50
m
36
b
e
g
k
c

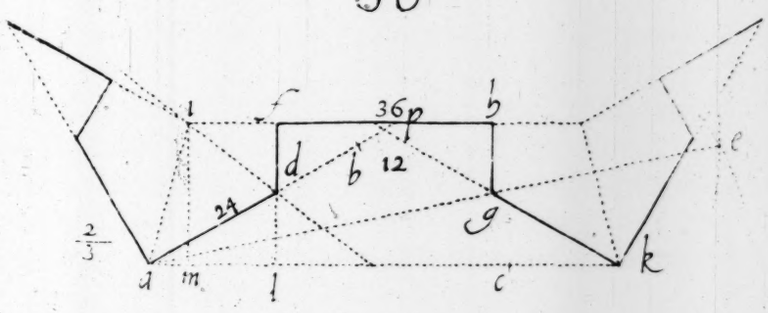

40


44
1
f
32
b
d
h
o
p
g
24
3/4
a
m
l
c
b

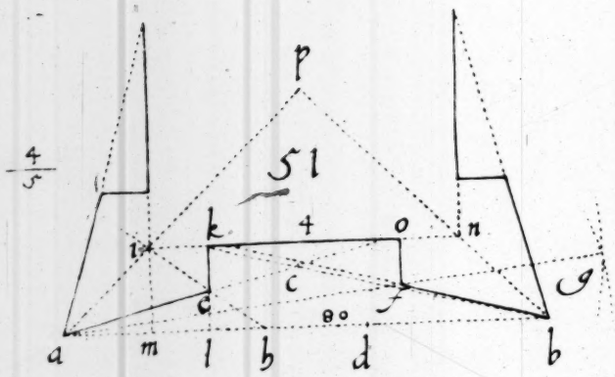

2c 44
D
f
n
36
m
g
c
2/3
d
o
b
24
a
p
o
l
c


47
1
f
36p
b
d
b
9
e
2/3
24
g
a
m
l
c
k

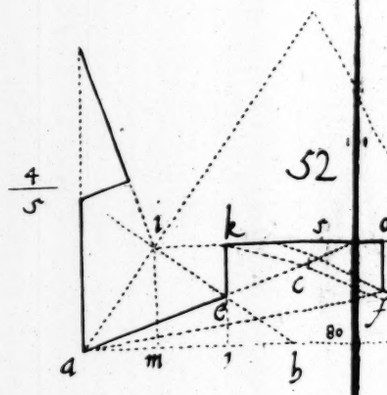

c
10
20
30
40
50
60
70
80
90
100


50
1
f
36p
b
d
b
12
e
2/3
24
g
d
m
l
c
k

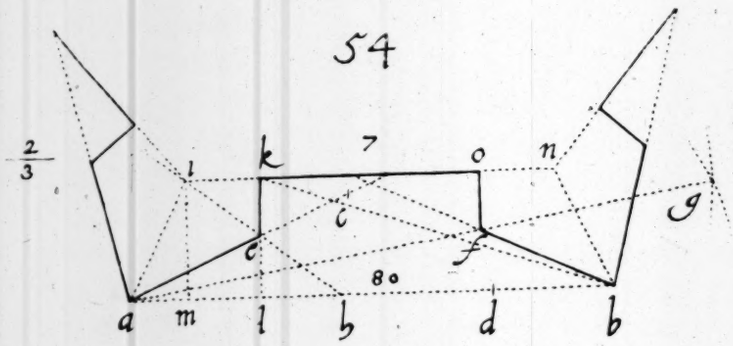
51


4/5
p
k
4
o
n
i
c
c
f
g
80
a
m
l
b
d
b

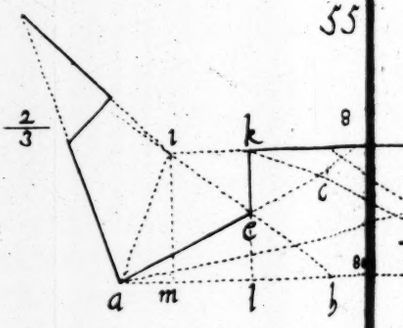
52


4/5
i
k
5
c
c
80
a
m
l
b

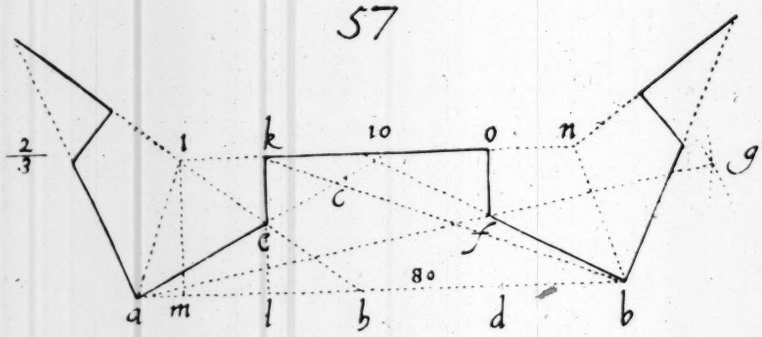
54

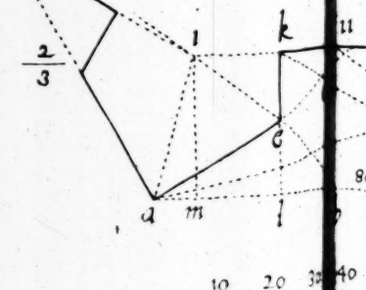

2/3
i
k
7
o
n
c
c
f
g
80
a
m
l
b
d
b

55

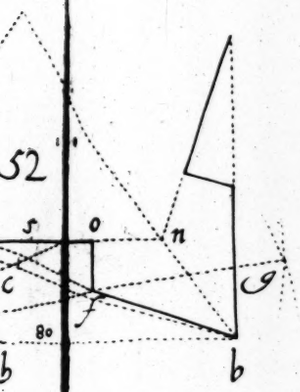

2/3
i
k
8
c
c
a
m
l
b

57

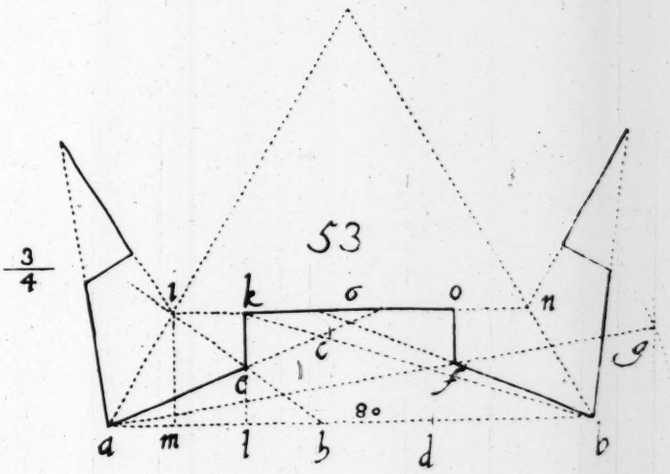

2/3
i
k
10
o
n
c
c
f
g
80
a
m
l
b
d
b


2/3
i
k
c
a
m
l

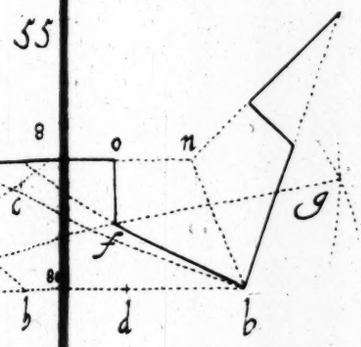
52



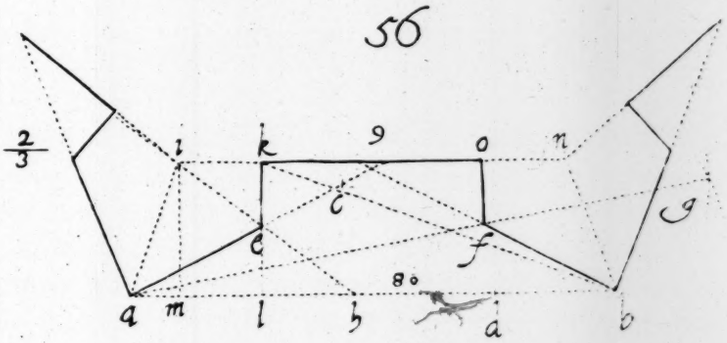
53



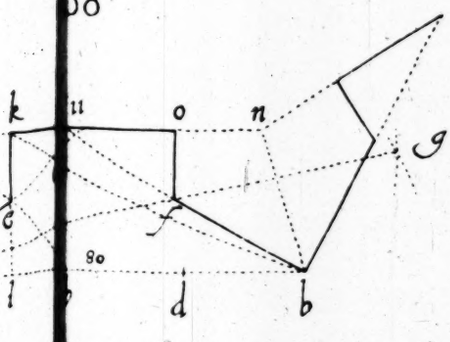
55



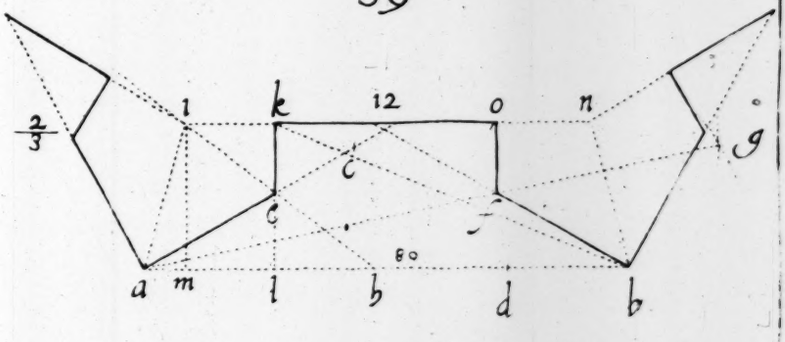
56

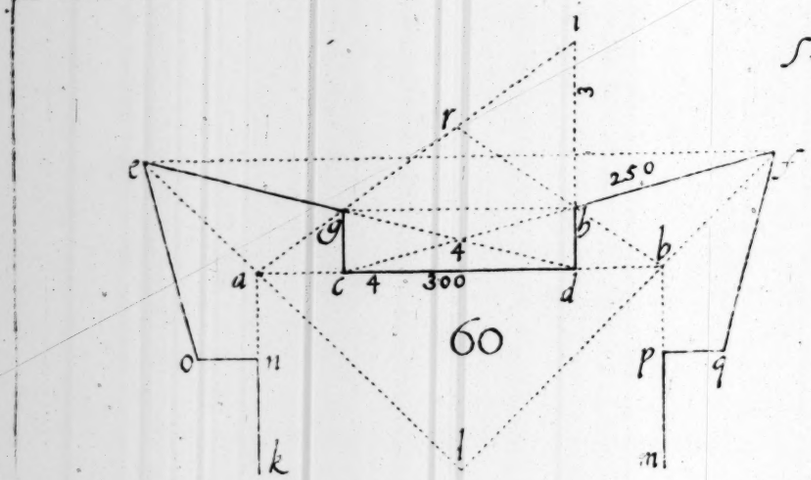


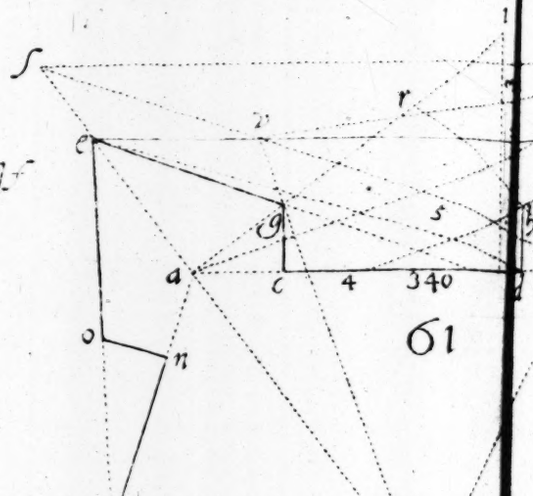
58

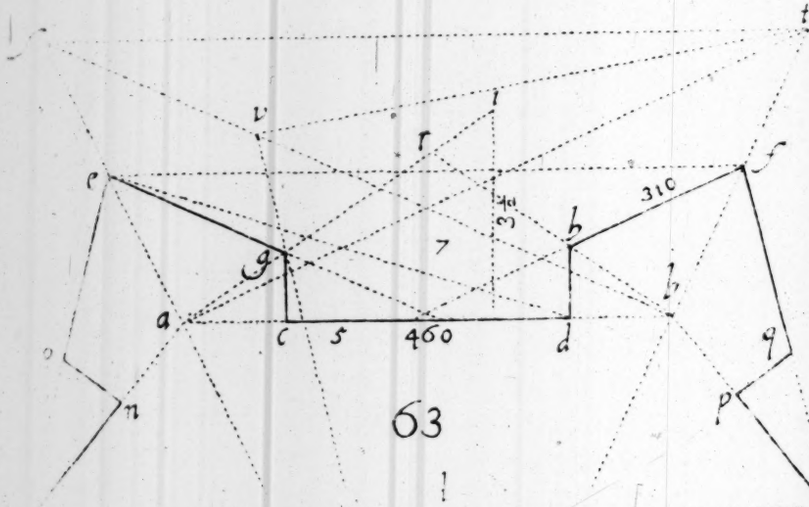


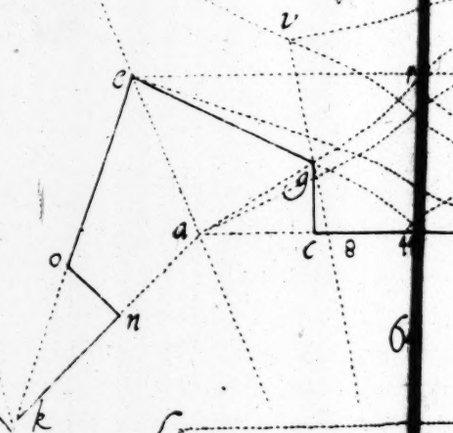
59

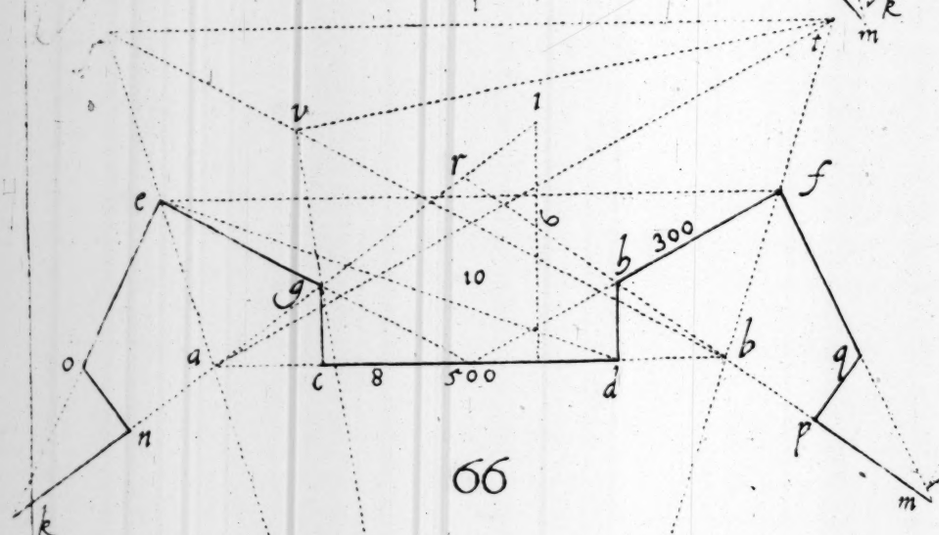


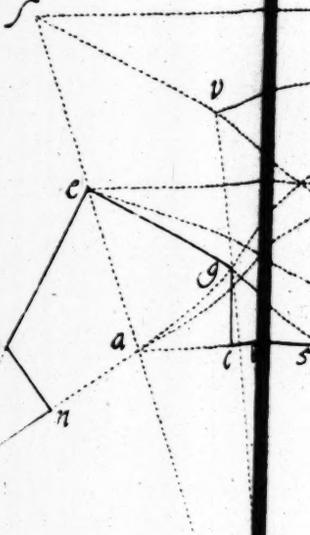

l
r
e
g
a
c 4 300 d
250
b
4
3
o
n
k
p
q
m
60

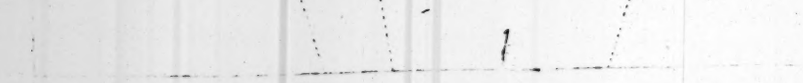

s
r
e
g
a
c 4 340
5
o
n
61

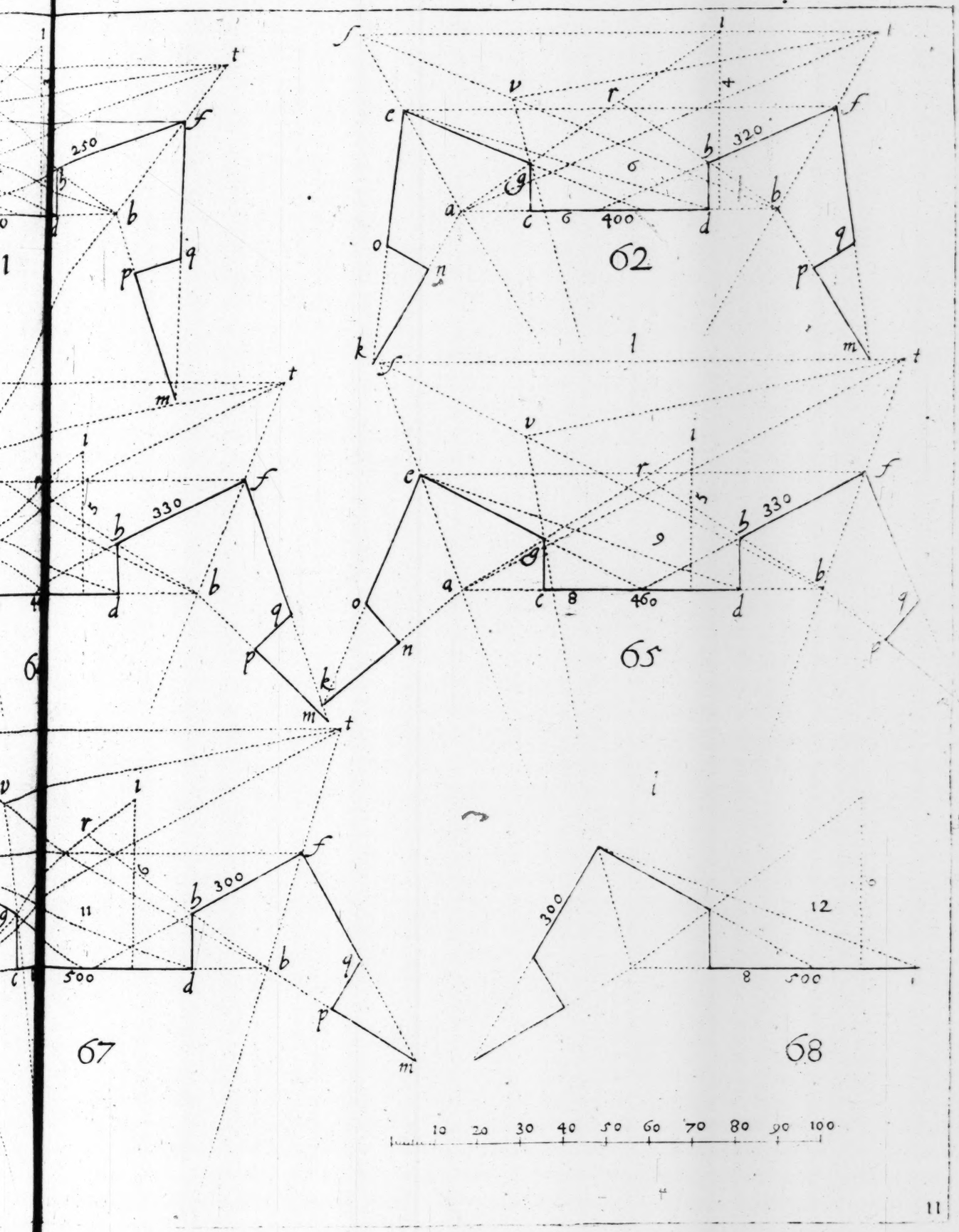

t
v
l
r
e
g
a
c 5 460 d
310
7
h
o
n
p
q
63

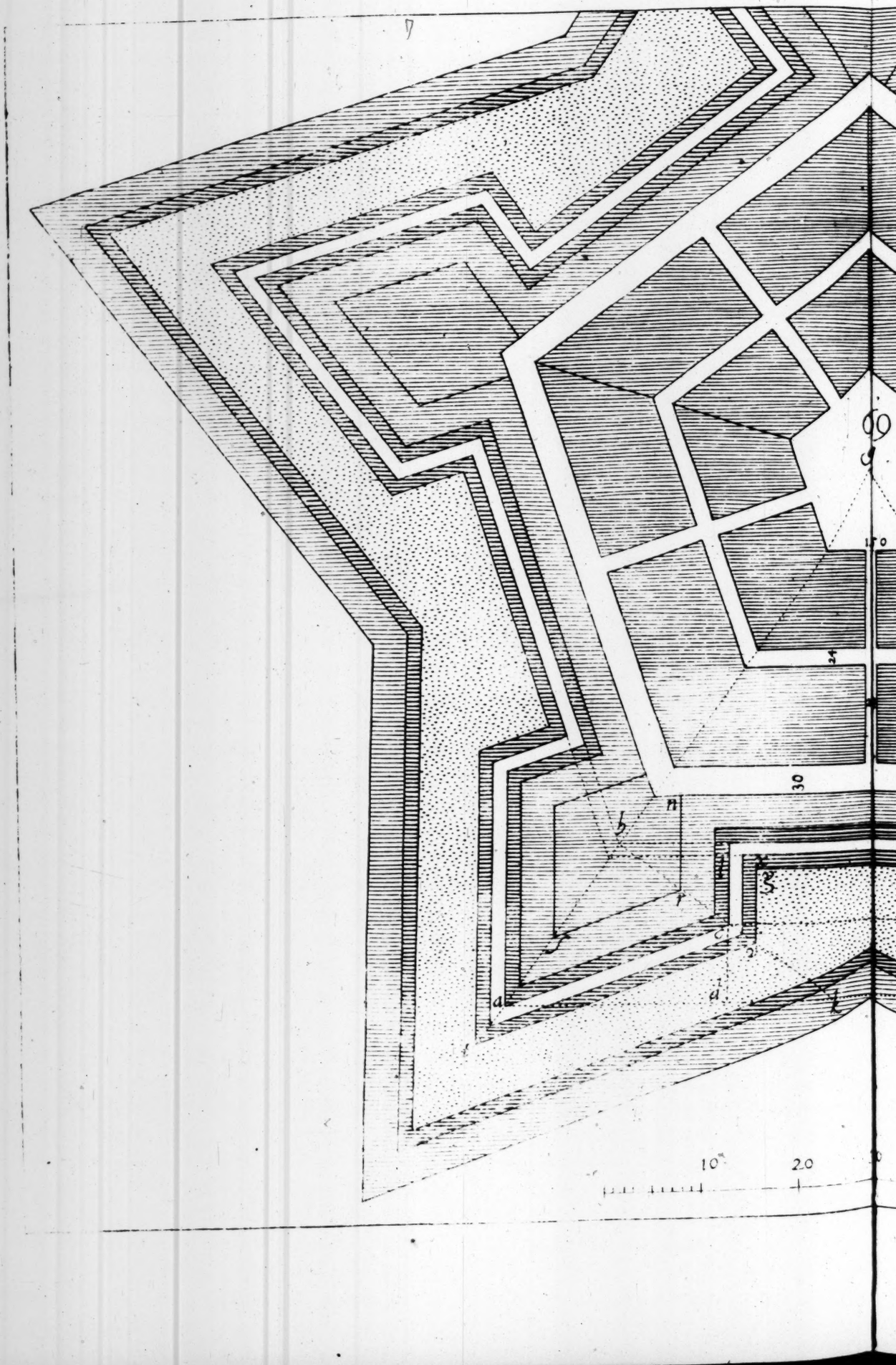

v
e
g
a
c 8
o
n
6

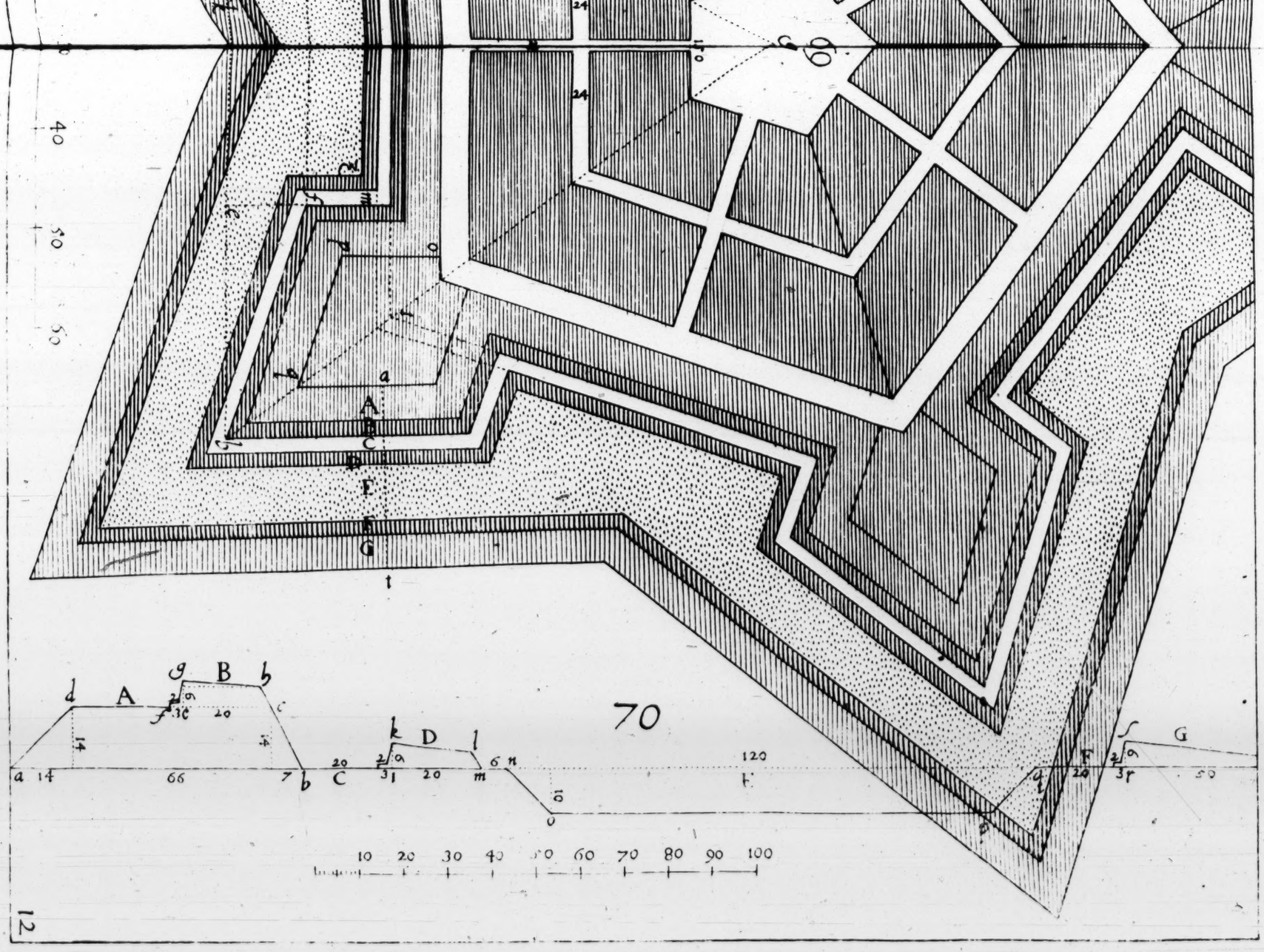

l
t
v
r
e
g
a
c 8 500 d
f
6
10
h 300
b
q
o
n
p
k
m
66


s
v
e
g
a
c
o
n
k
m

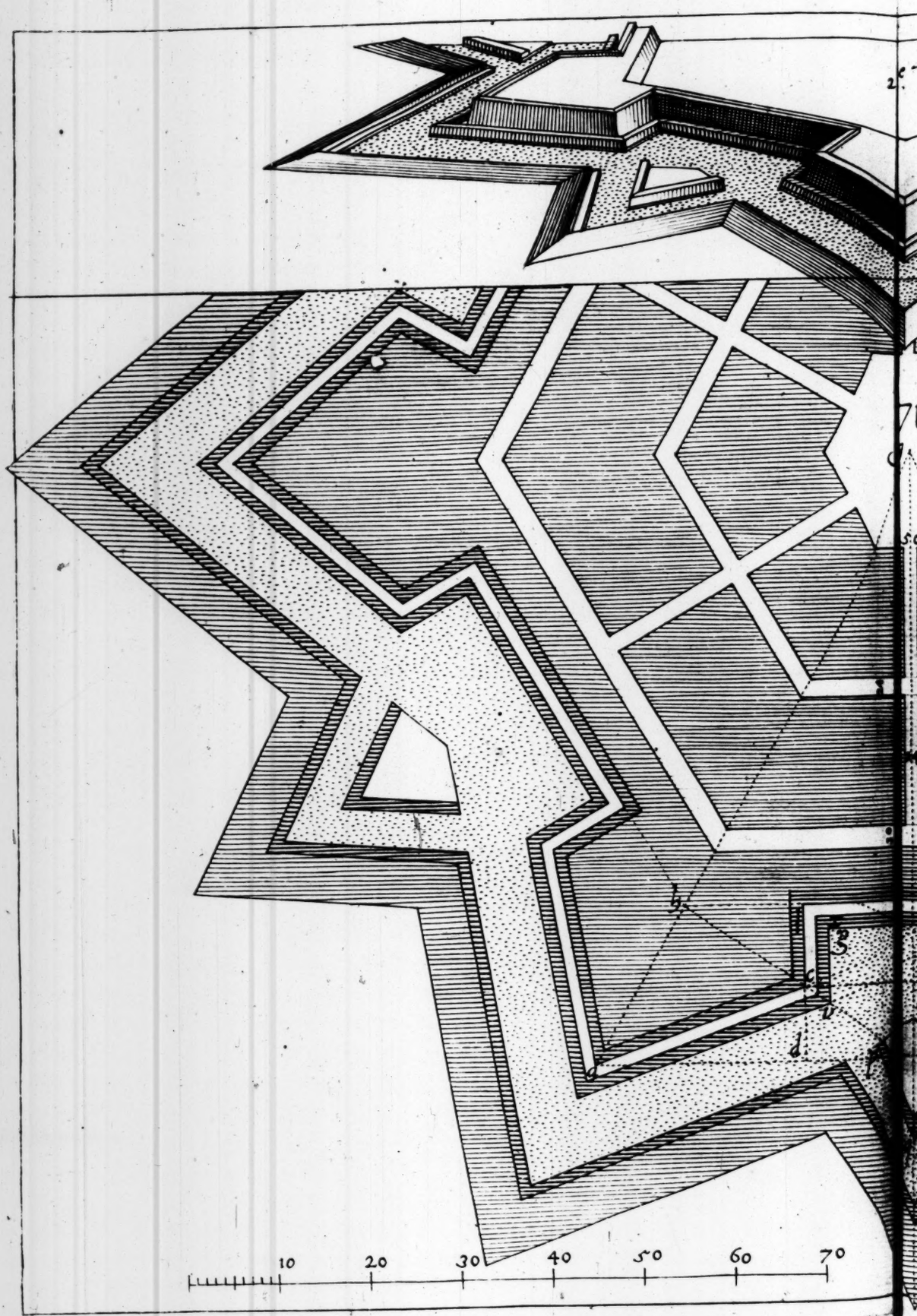

l

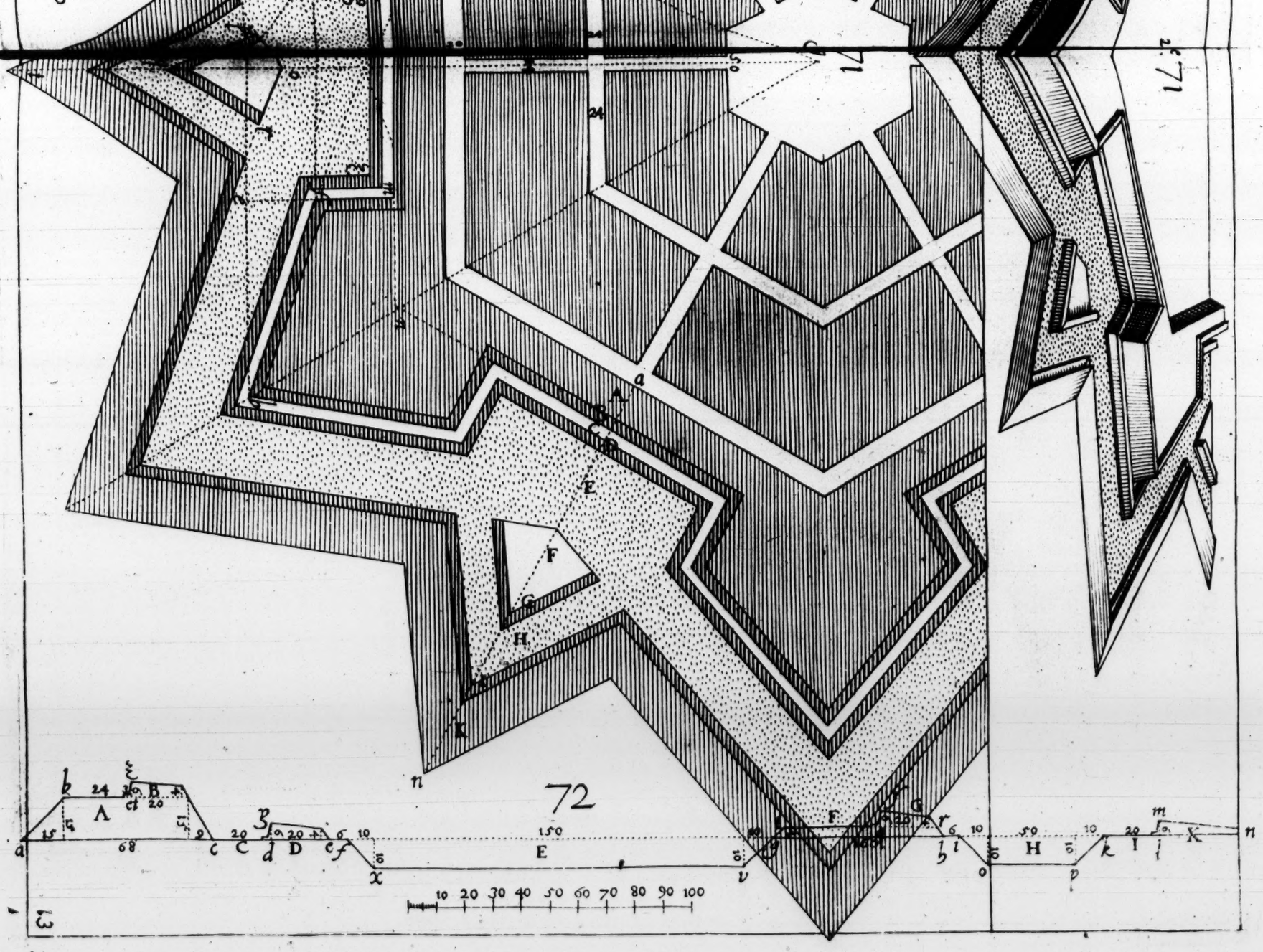

250
330
320
330
300
300
400
460
500
500
62
65
67
68
10 20 30 40 50 60 70 80 90 100

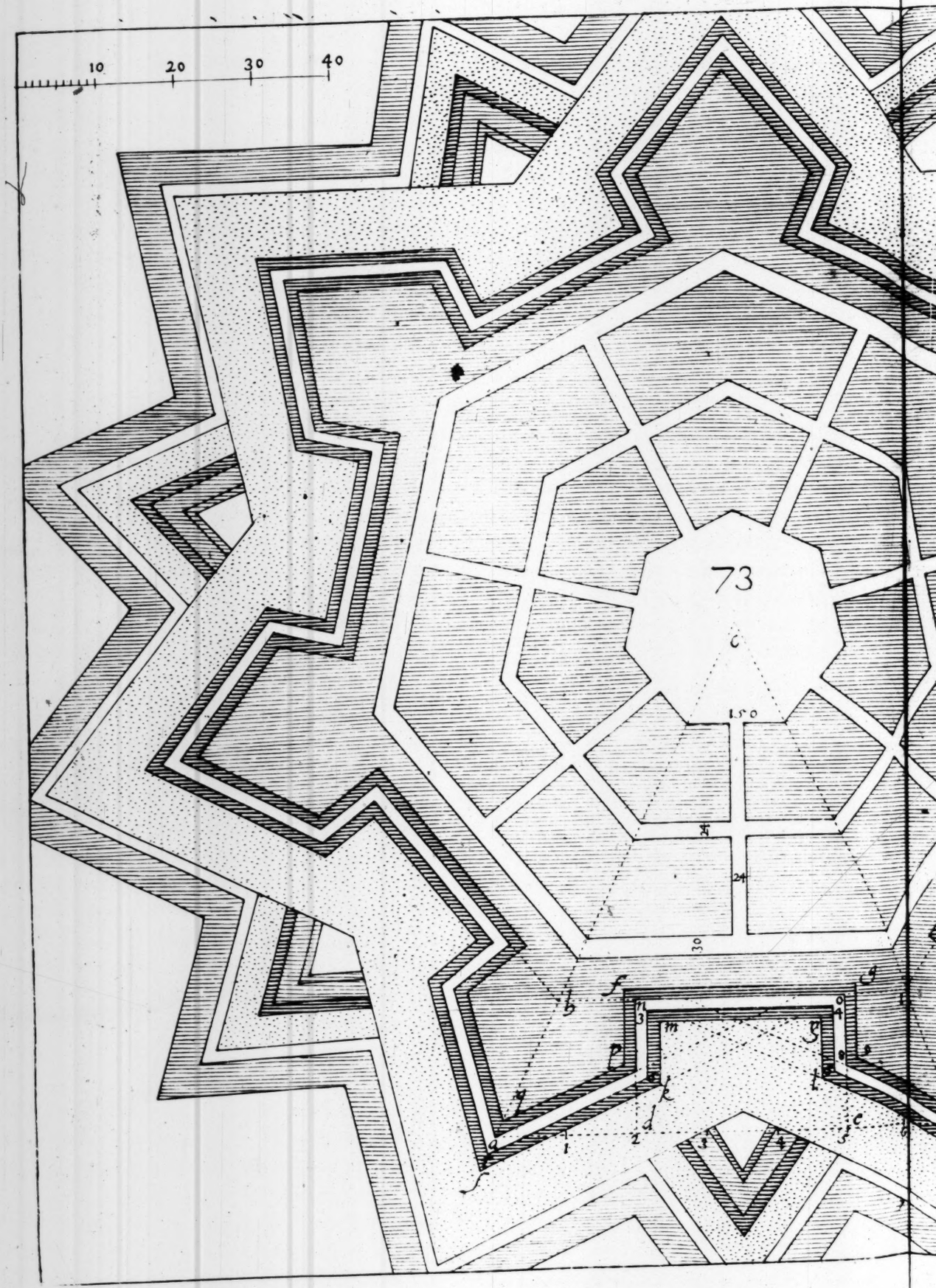

30
b
n
a
a
10
20

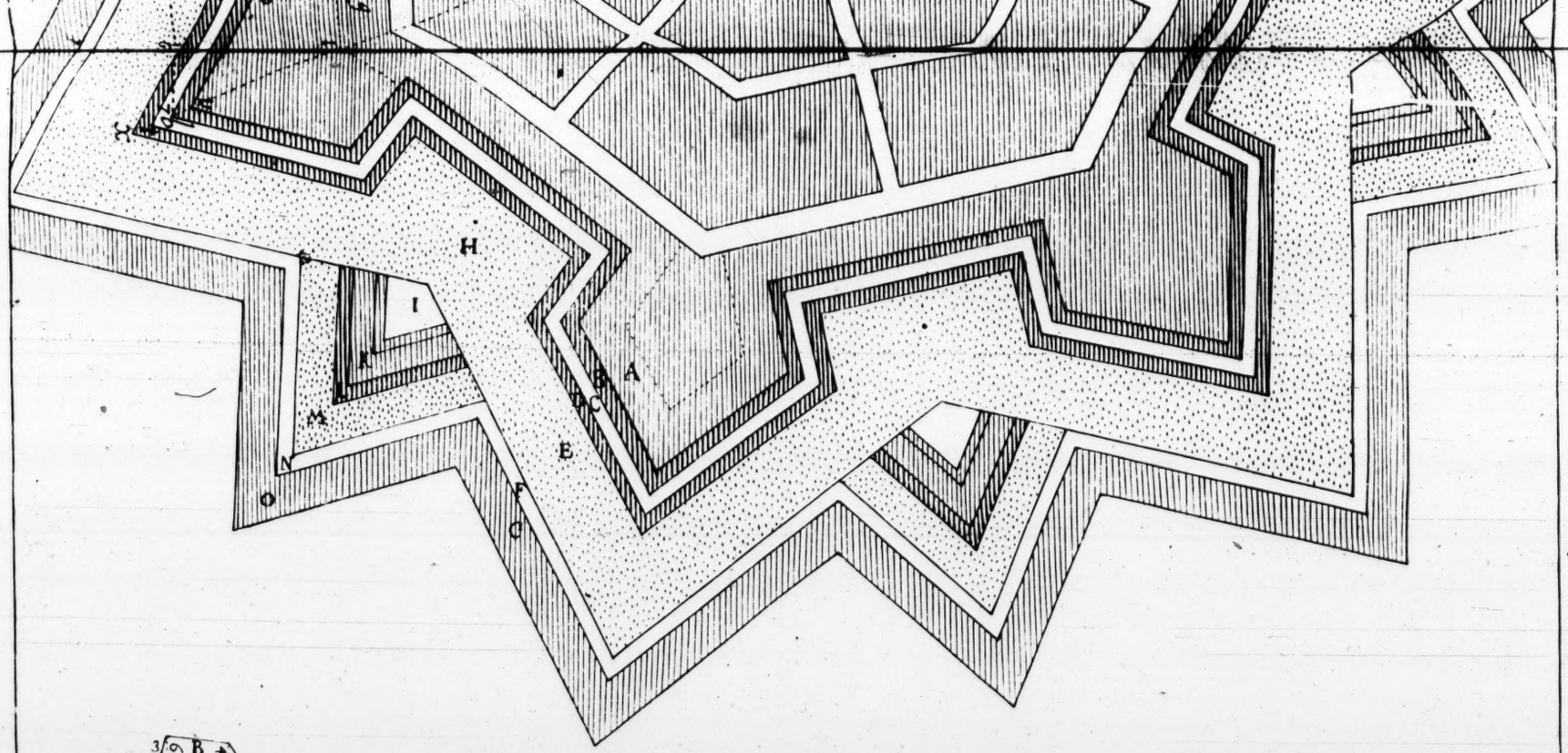

A
B
C
D
E
F
G
a
b
c
d
e
f
g
h
i
k
l
m
n
o
p
q
r
s
t
70
60
24
40
50
10 20 30 40 50 60 70 80 90 100

12

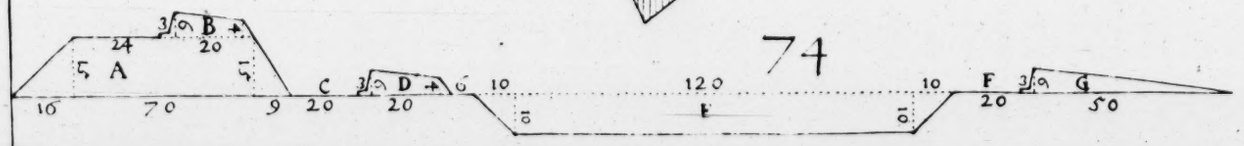

10
20
30
40
50
60
70


A
B
C
D
E
F
G
H
K
a
n
72
10 20 30 40 50 60 70 80 90 100

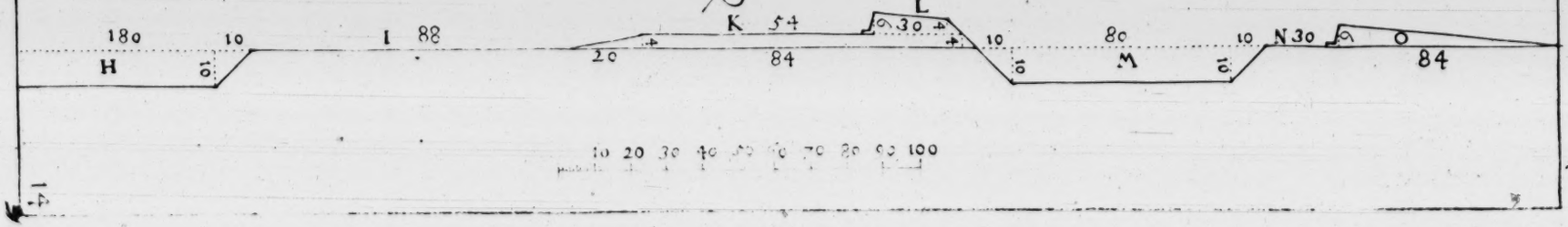

10
20
30
40
73
c
150
24
30
b
f
g
m
p
q
k
d
l
z
e
s
t

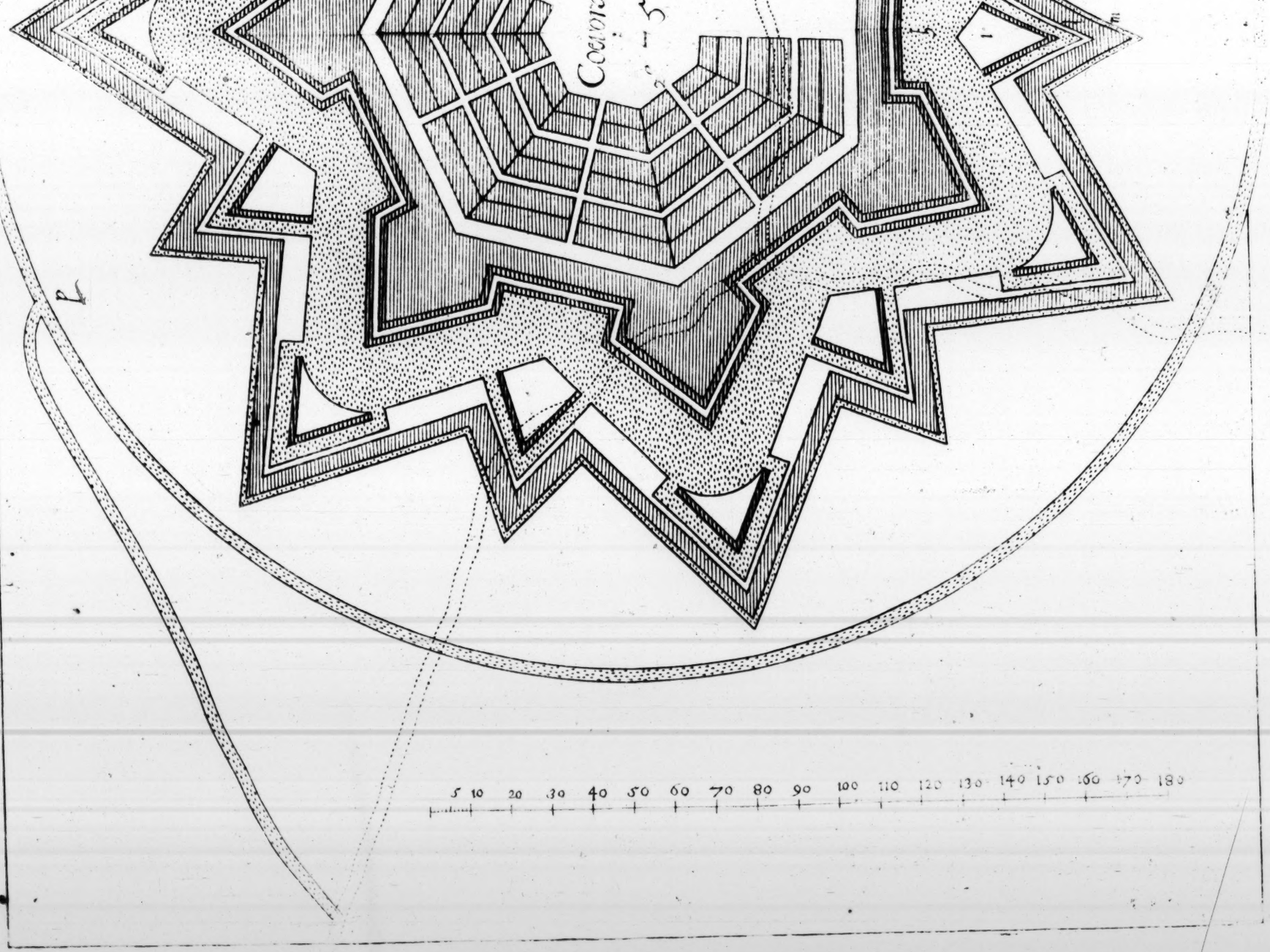

H
I
K
M
N
O
B
A
C
E
F
C

74


A
B
C
D
E
F
G
24
20
70
9
20
20
10
120
10
20
50

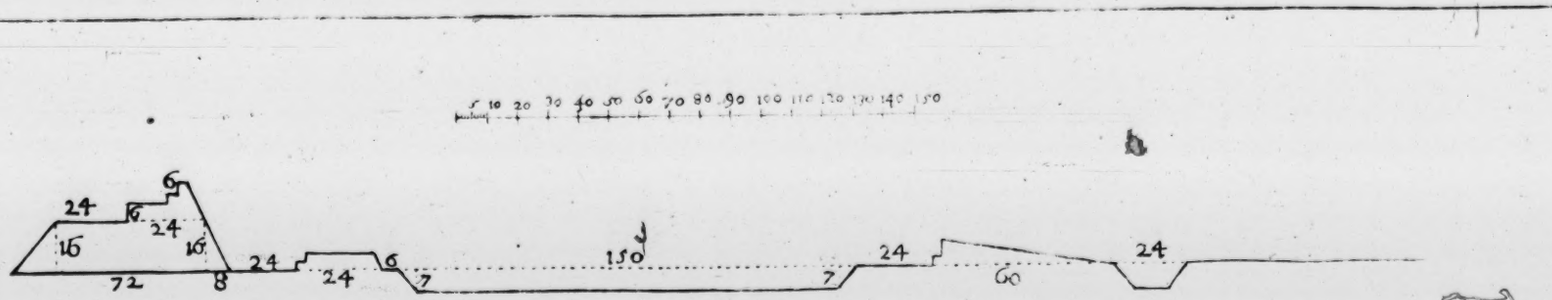
75

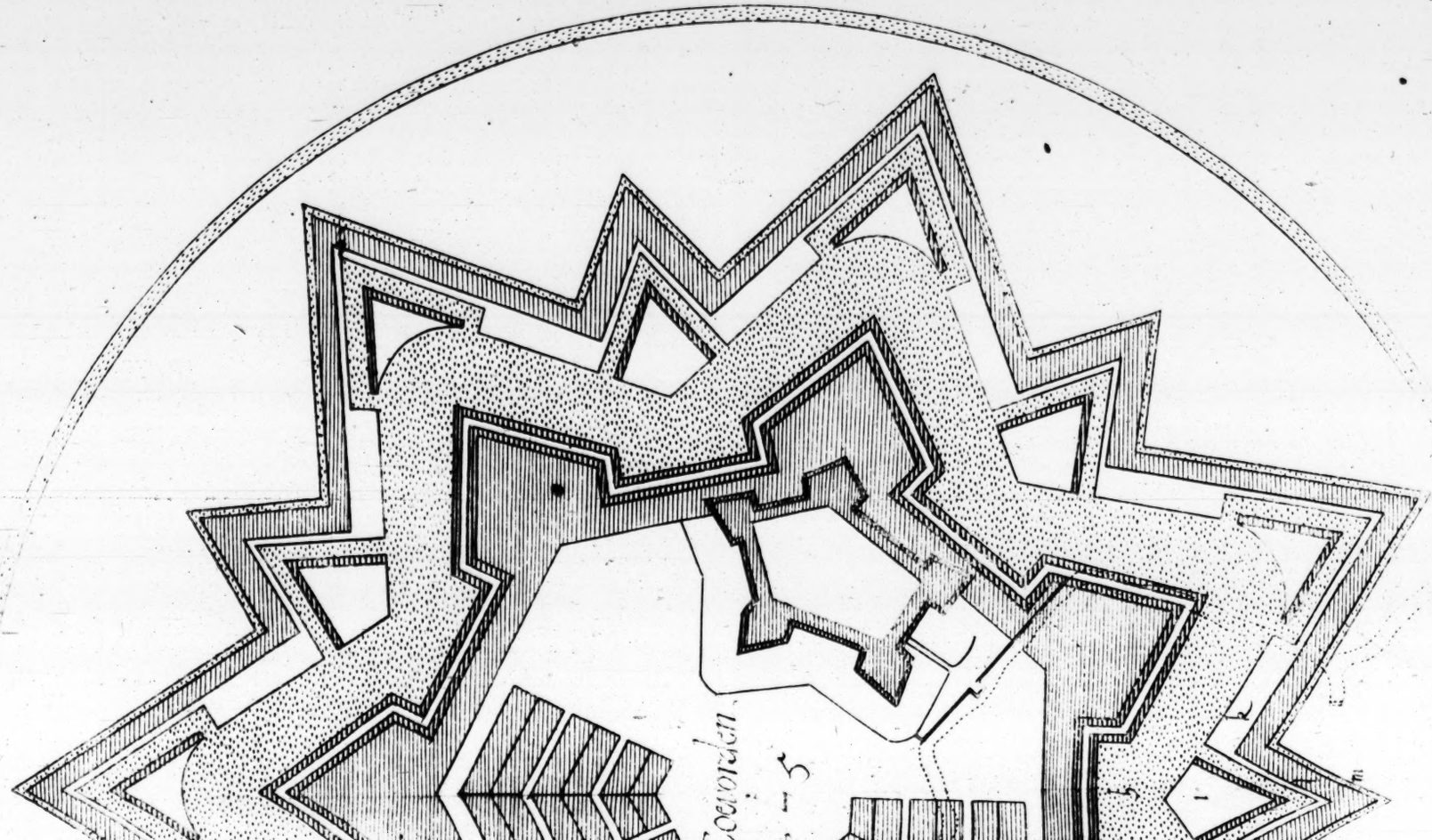

H
I
K
L
M
N
O
180
10
88
54
30
80
30
84
84
10 20 30 40 50 60 70 80 90 100

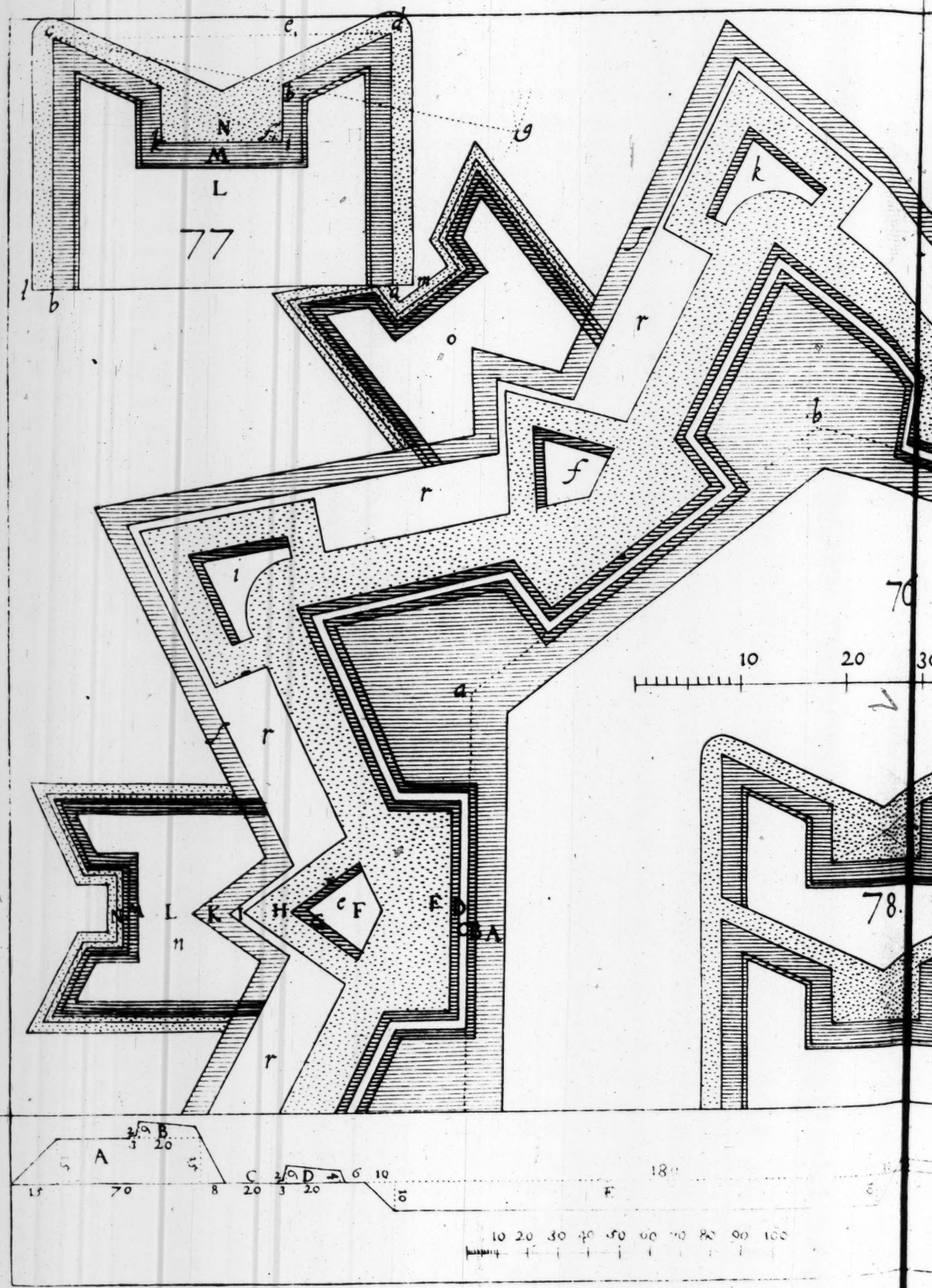


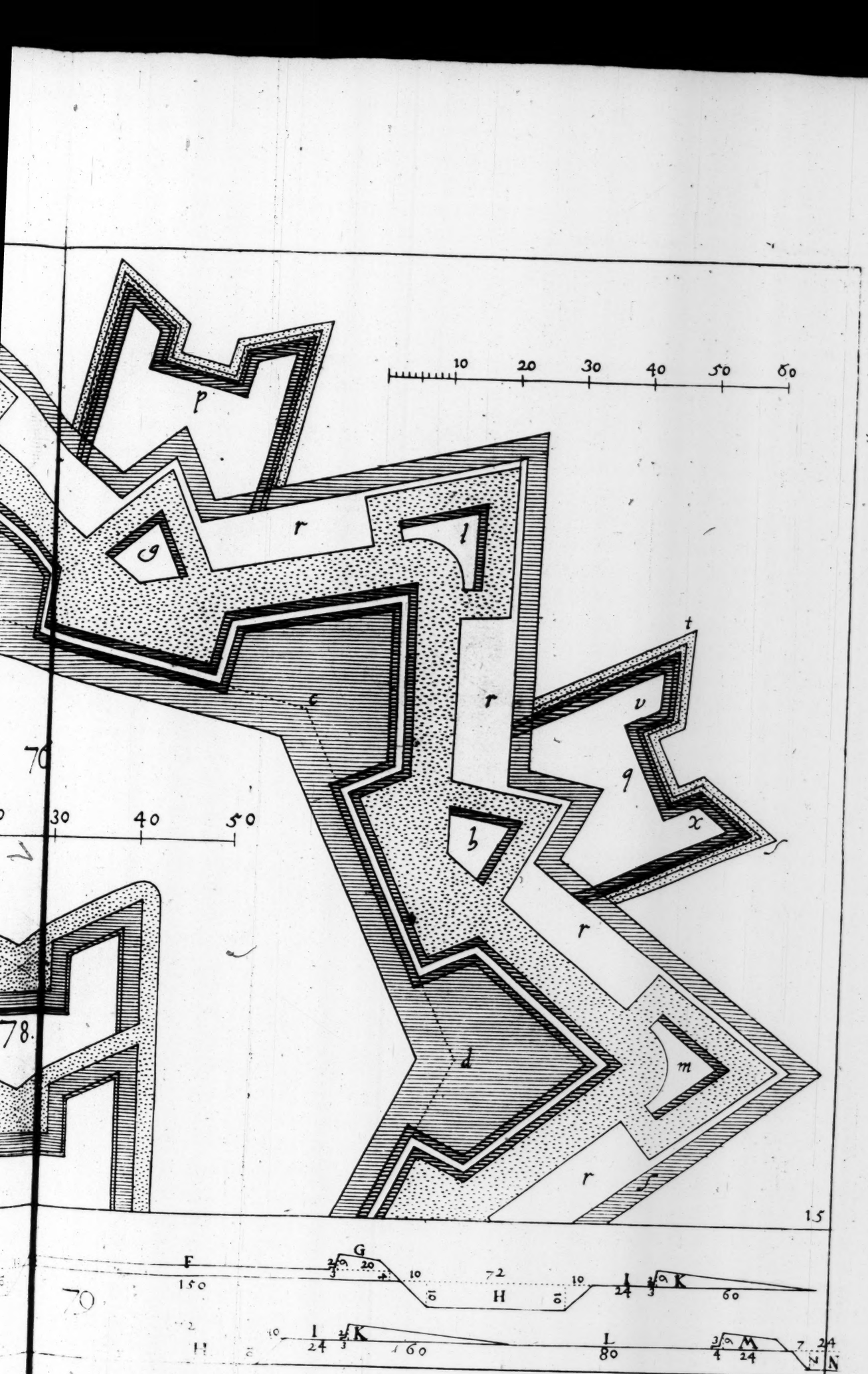
5 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180

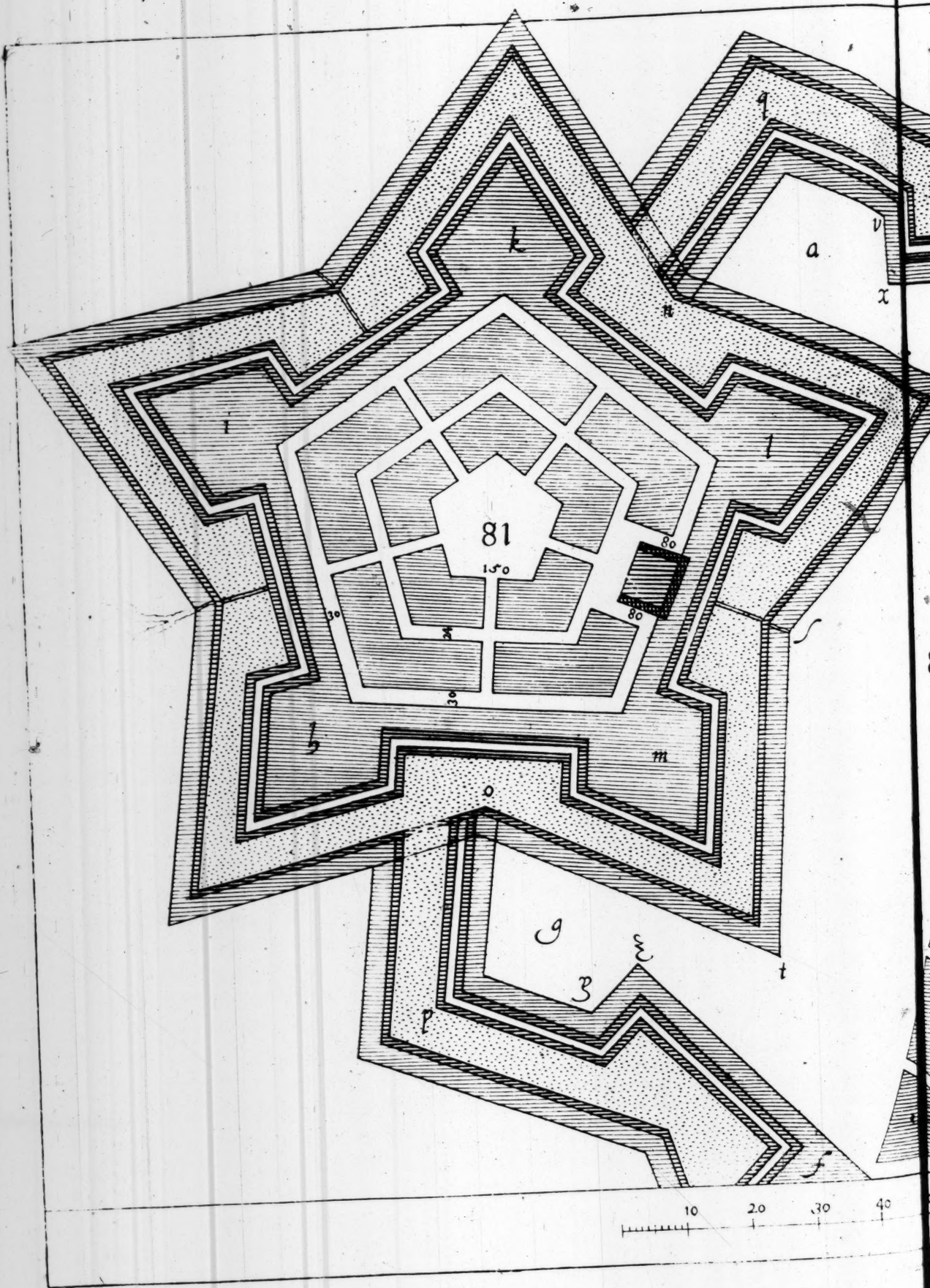
2c 14

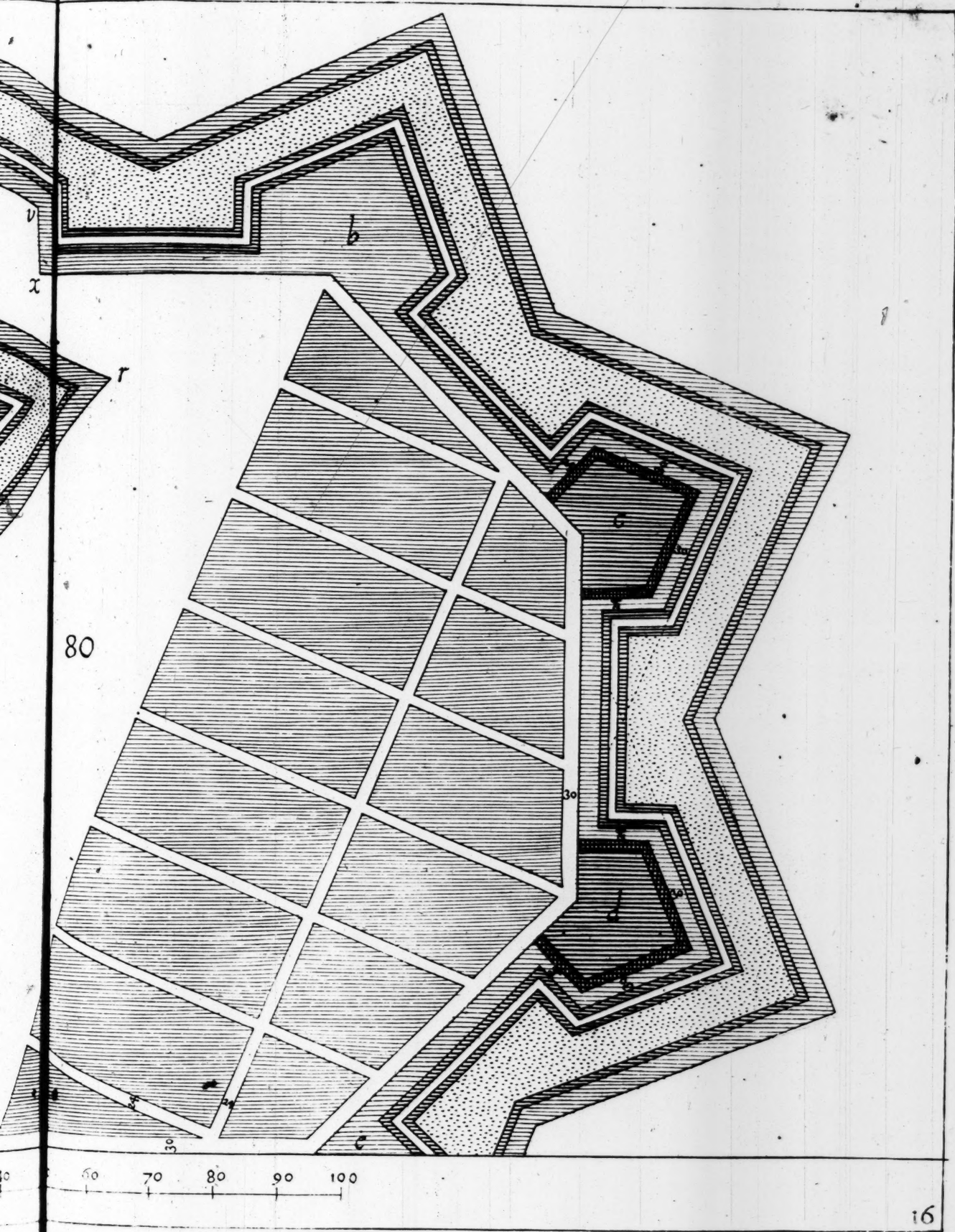


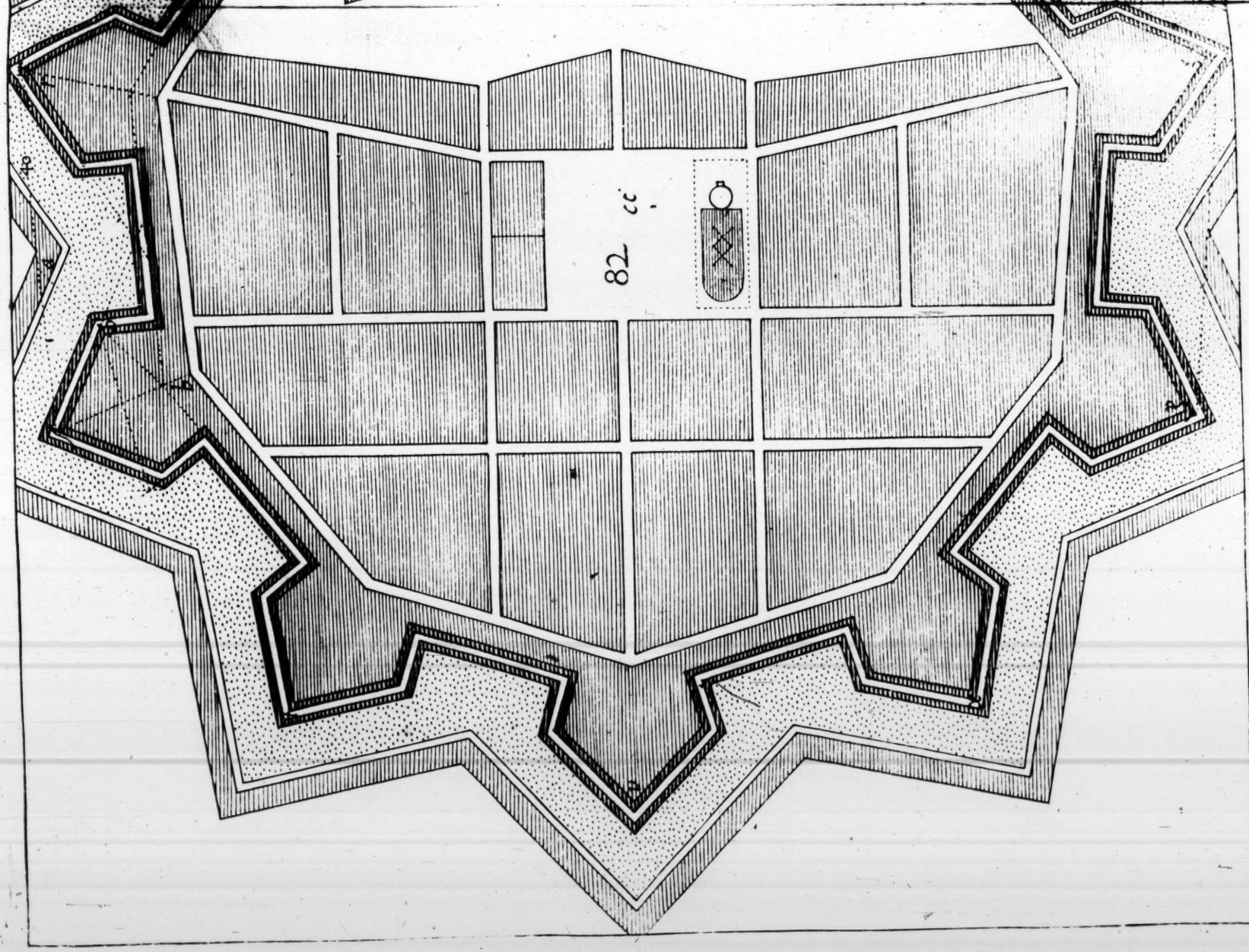


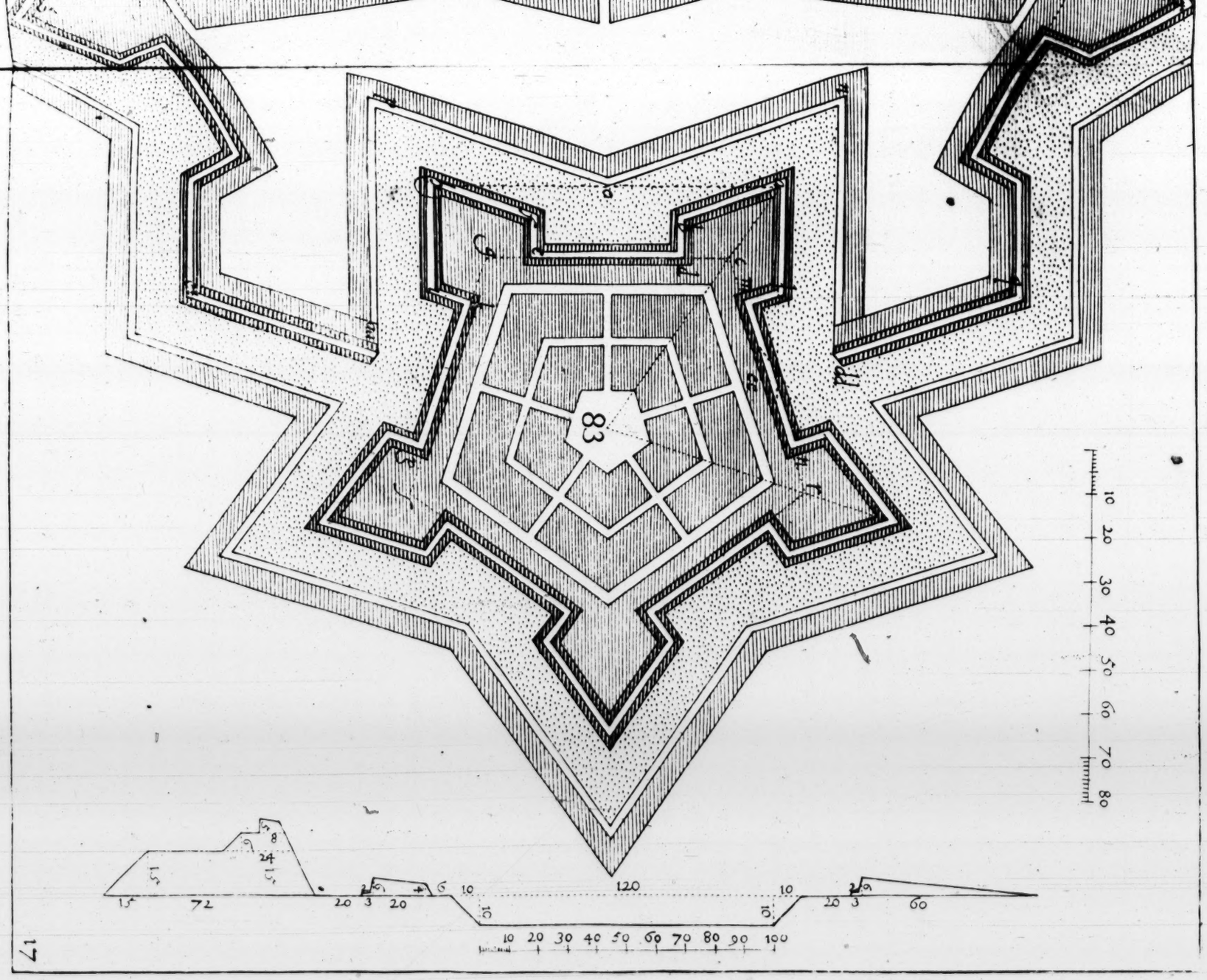

77
78
L
N
M
A
B
C
D
E
F
G
H
K
L
N
a
b
c
d
e
f
g
k
l
m
n
o
r
10 20 30 40 50 60 70 80 90 100

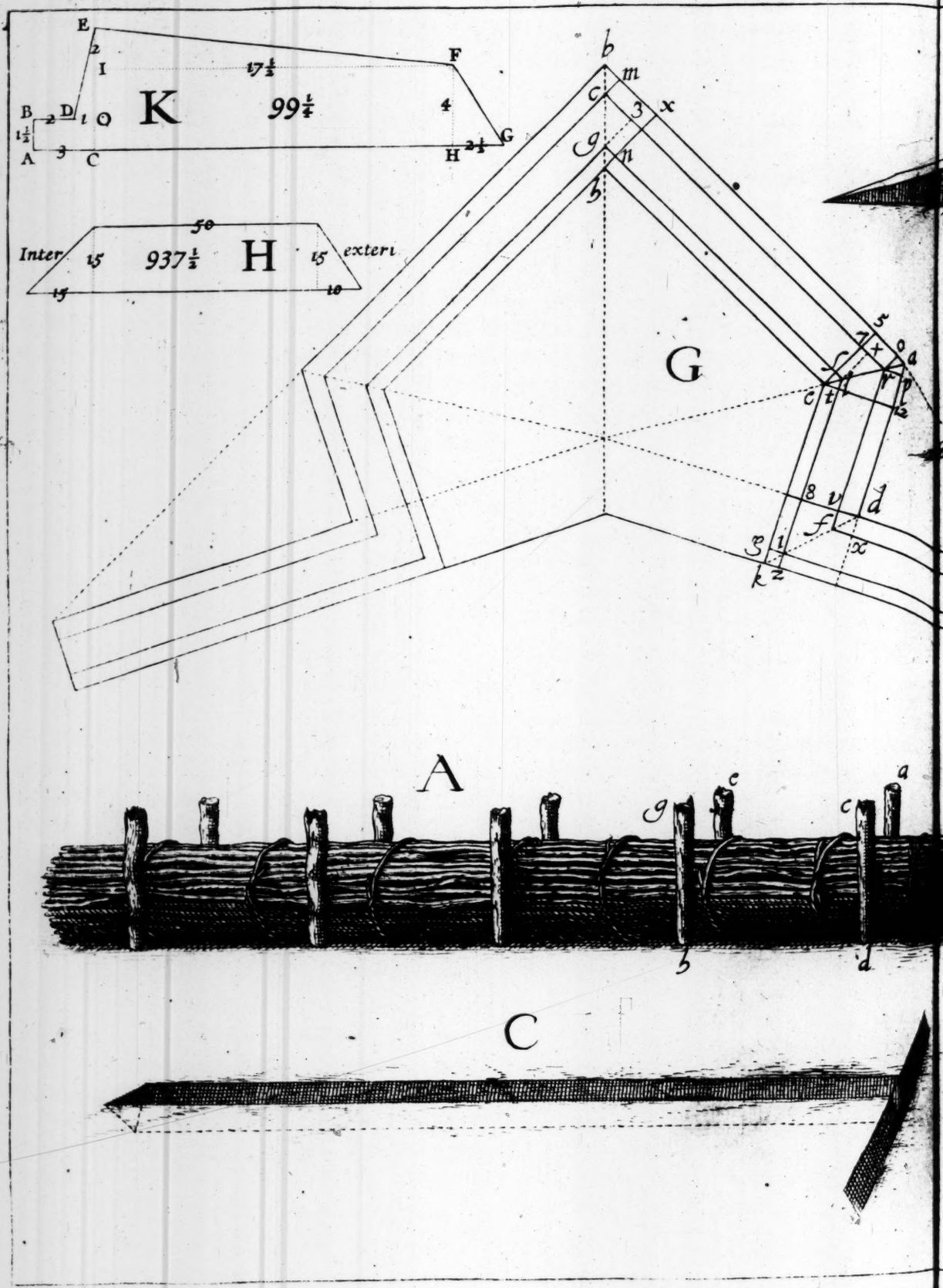

10 20 30 40 50 60
p
g
r
l
t
e
r
v
q
x
b
r
d
m
r
15
F
150
G
20
10
72
10
H
K
60
I
24
K
160
L
80
M
24
N

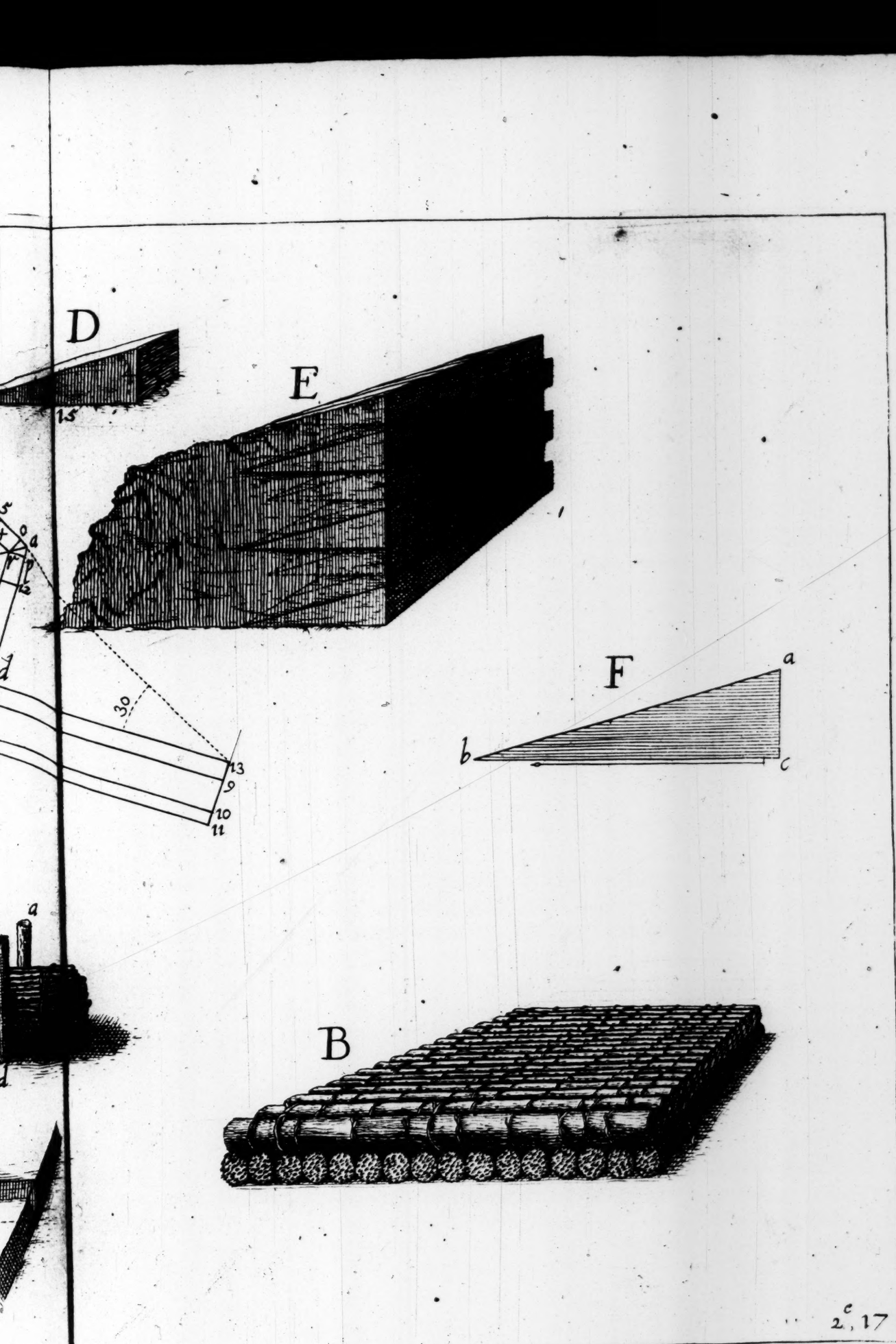

81
150
80
80
30
30
30
a
b
c
d
e
f
g
h
i
k
l
m
n
o
p
q
r
s
t
v
x
y
z
10
20
30
40


v
x
r
b
80
30
50
70
80
90
100

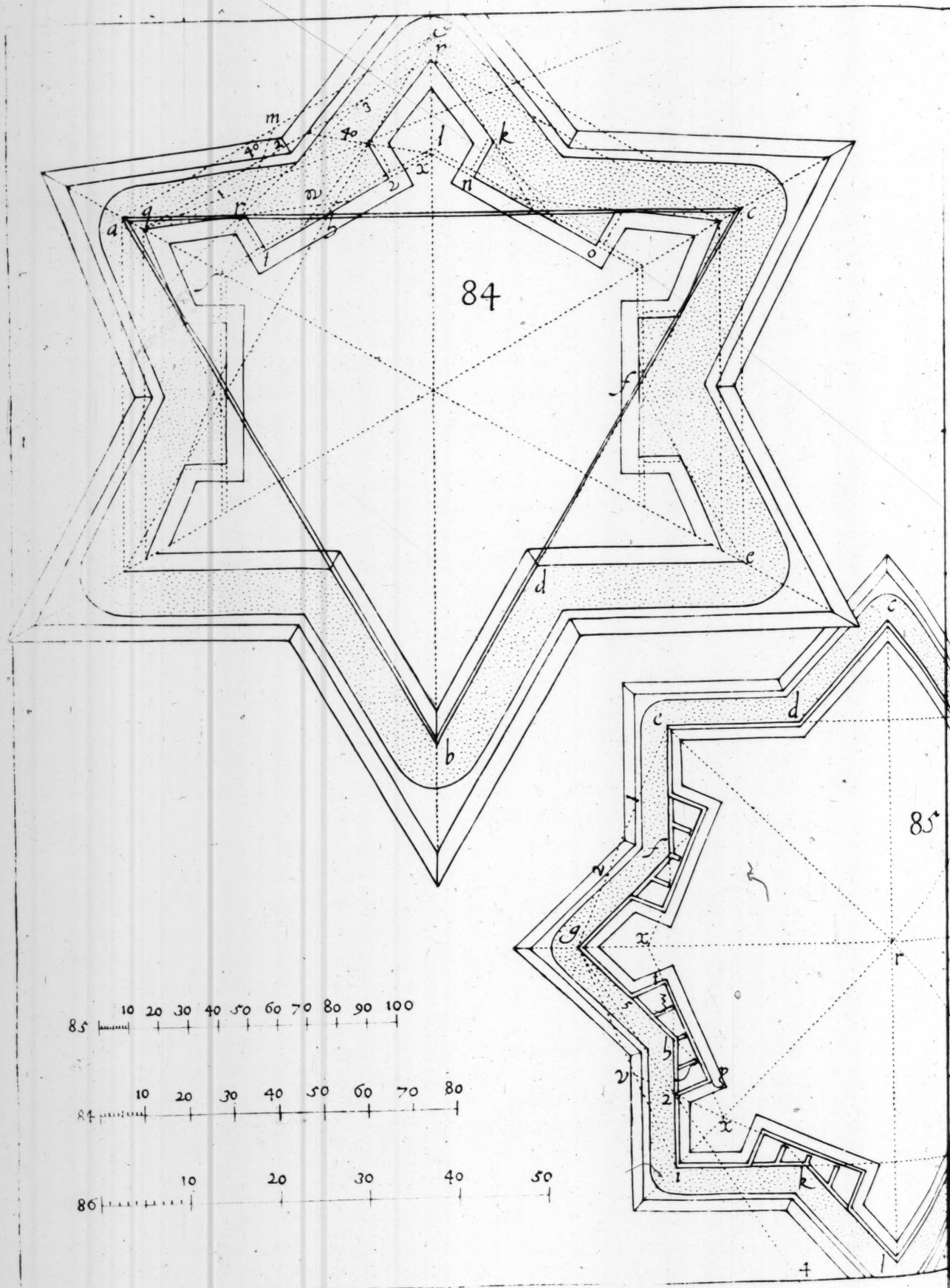

82 cc

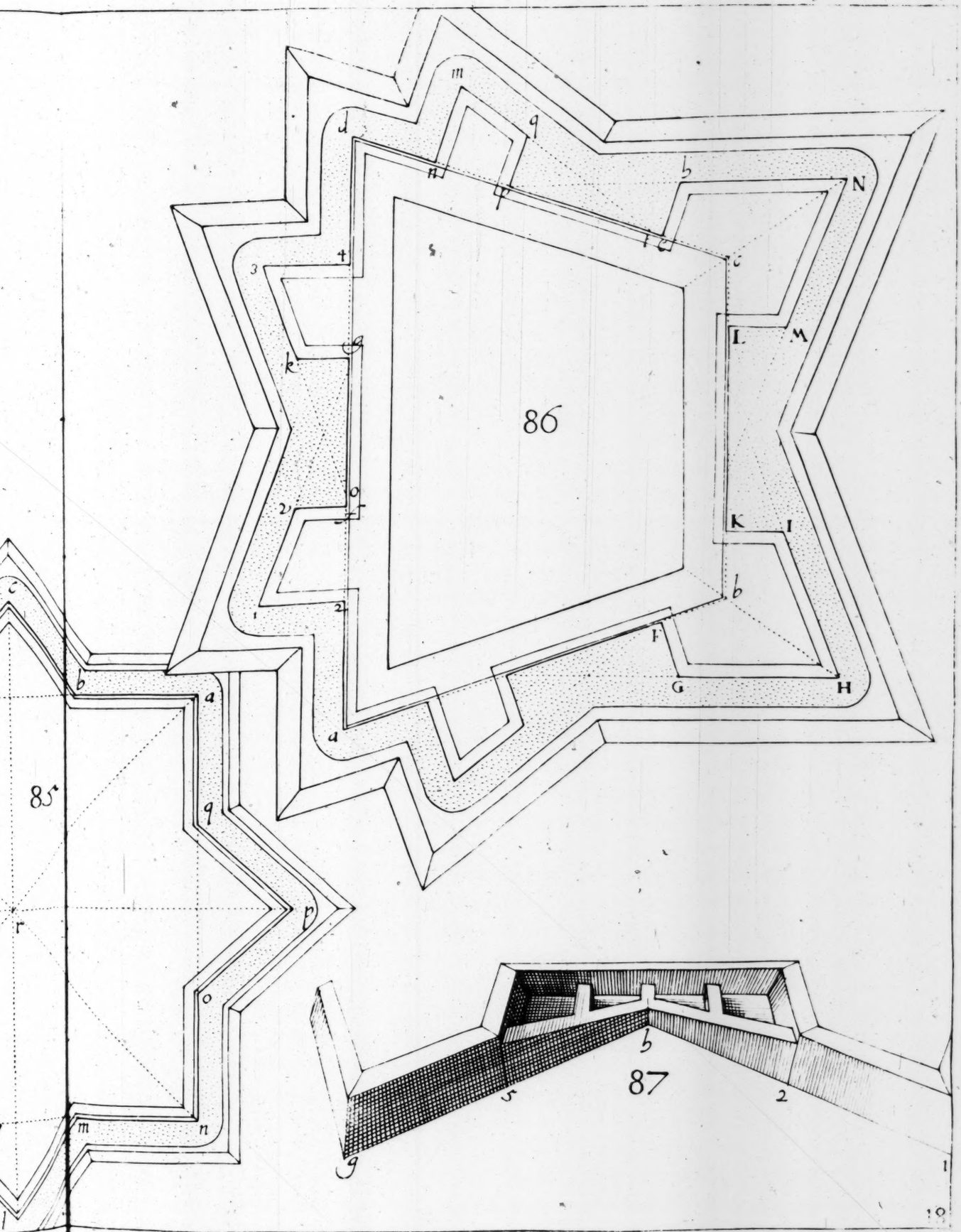

83
10 20 30 40 50 60 70 80
15 72 20 3 20 10 120 10 20 3 60
10 20 30 40 50 60 70 80 90 100

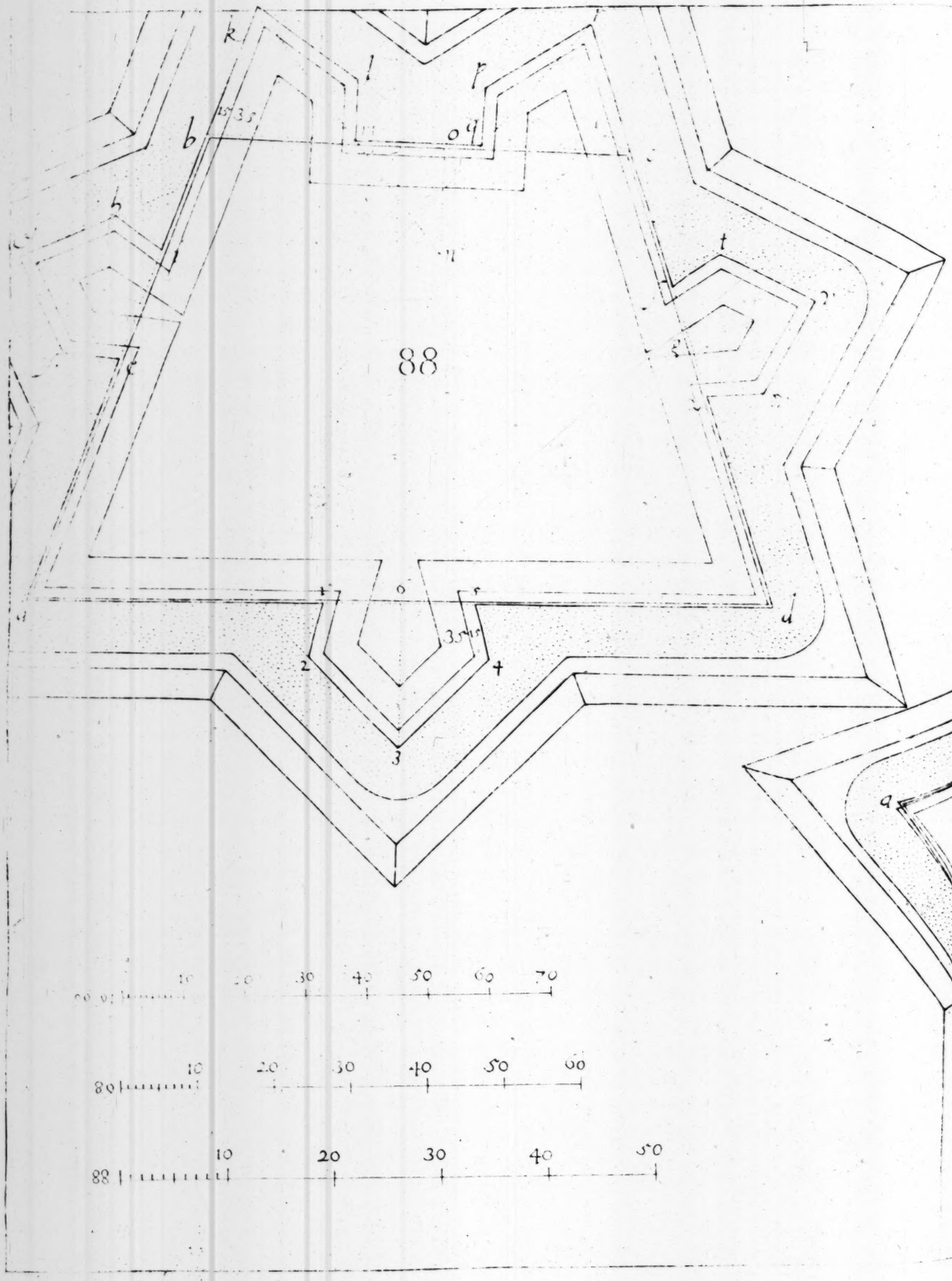

K
99¼
H
937½
Inter
exteri
G
A
C

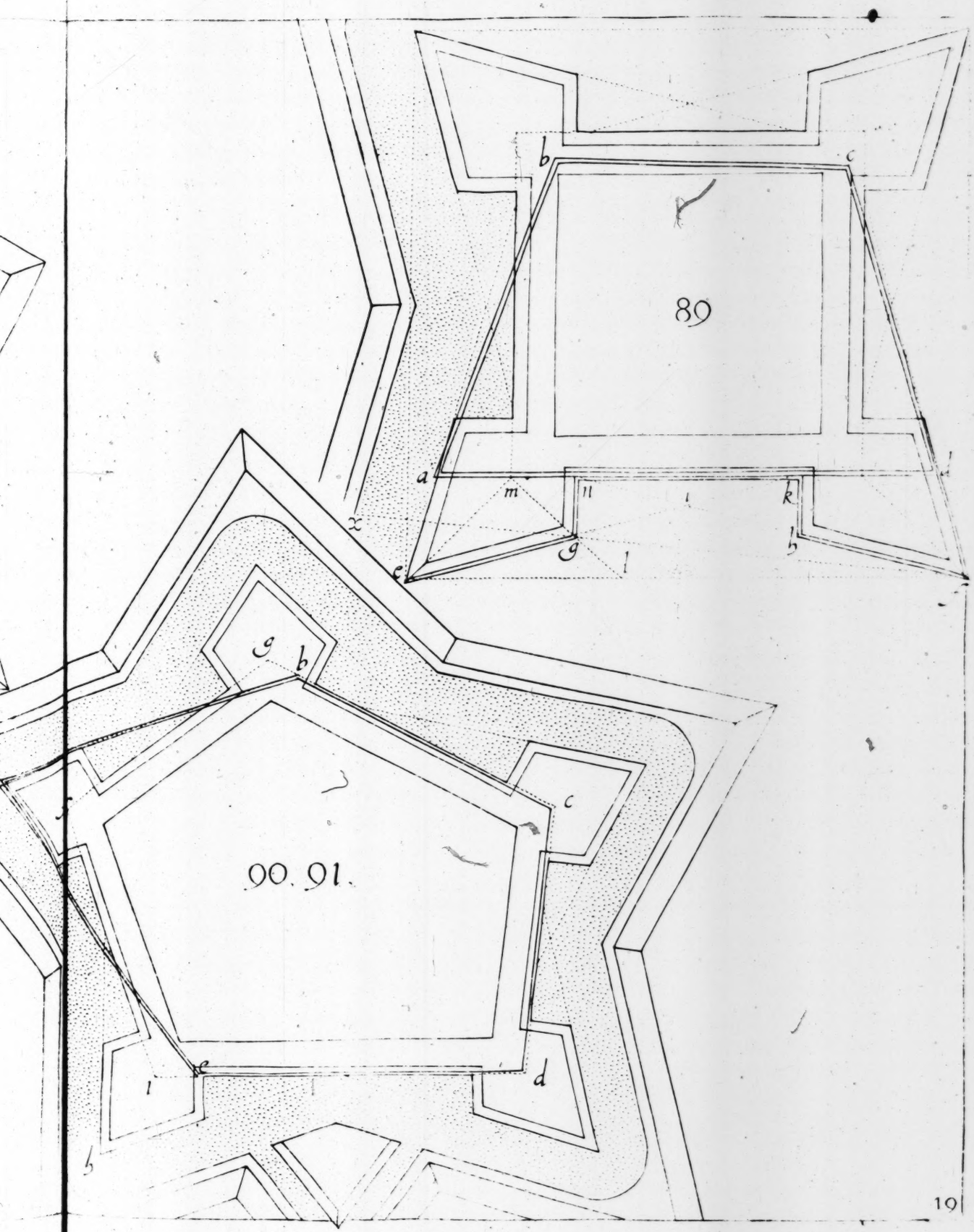


2. c. 17

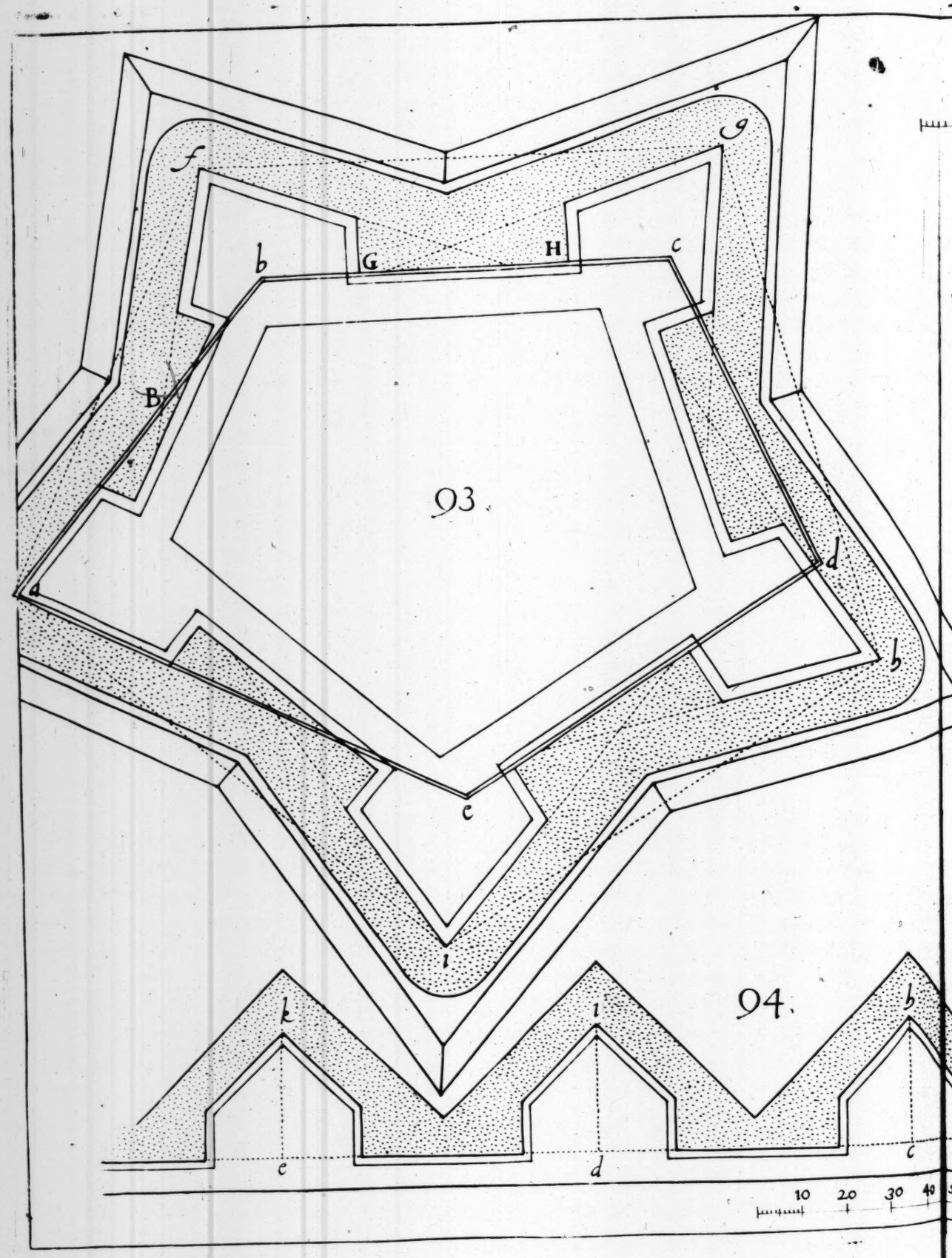

84
85
10 20 30 40 50 60 70 80 90 100
10 20 30 40 50 60 70 80
10 20 30 40 50

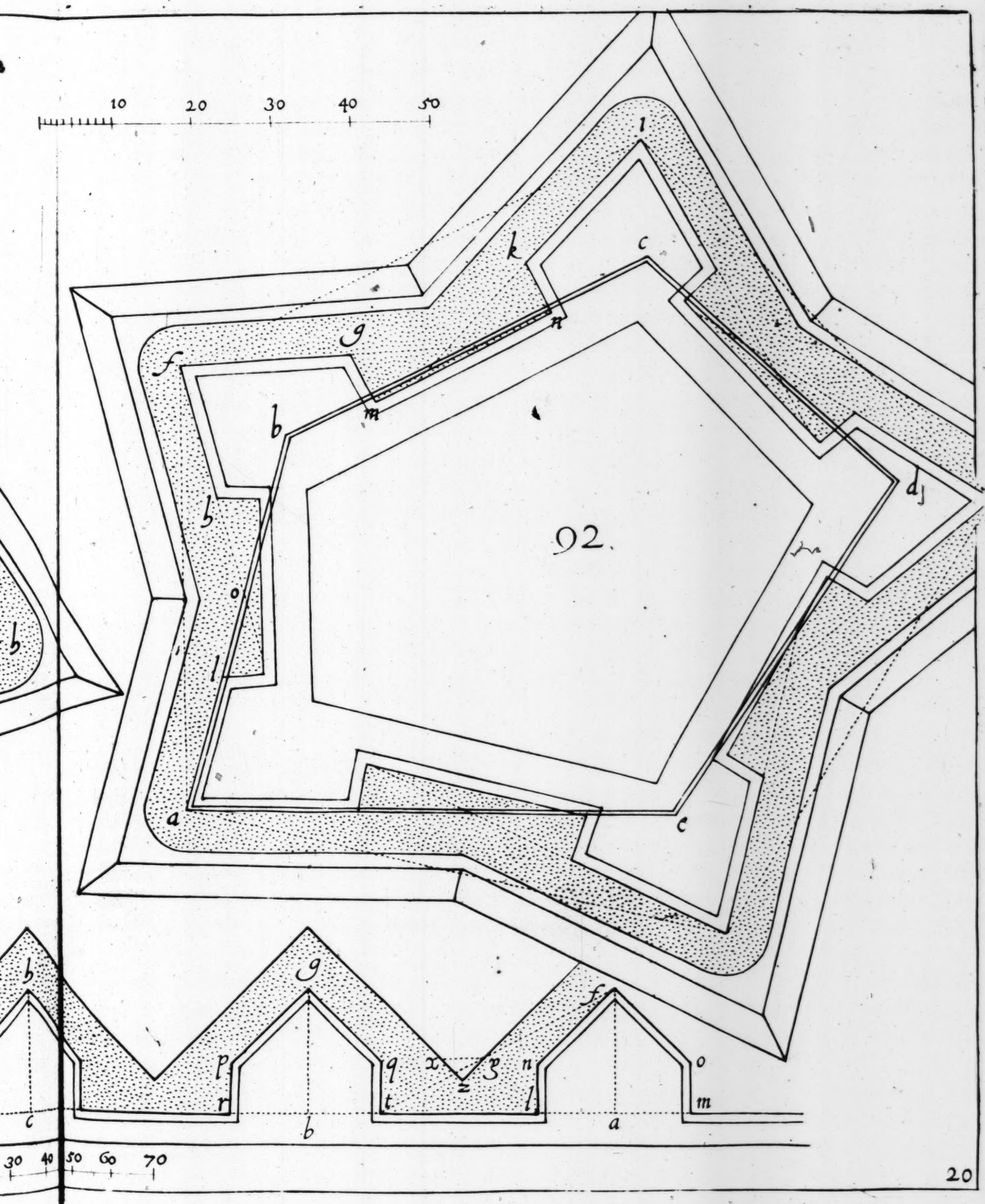

86
85
87
m
d
q
n
p
b
N
c
L
M
K
I
G
H
F
a
k
o
r
s
1
2
3
4
5
l

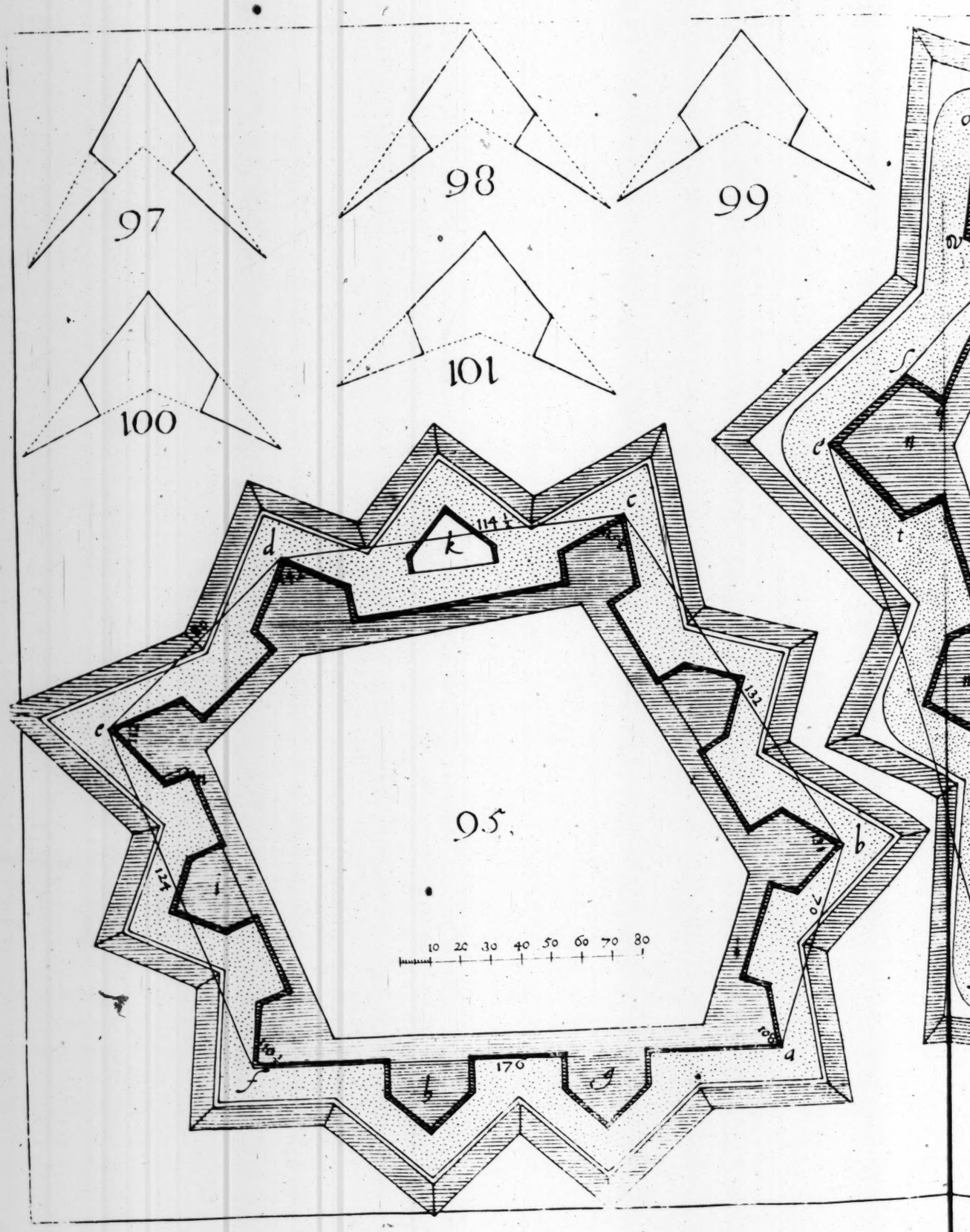

88
10
20
30
40
50
60
70
80
88

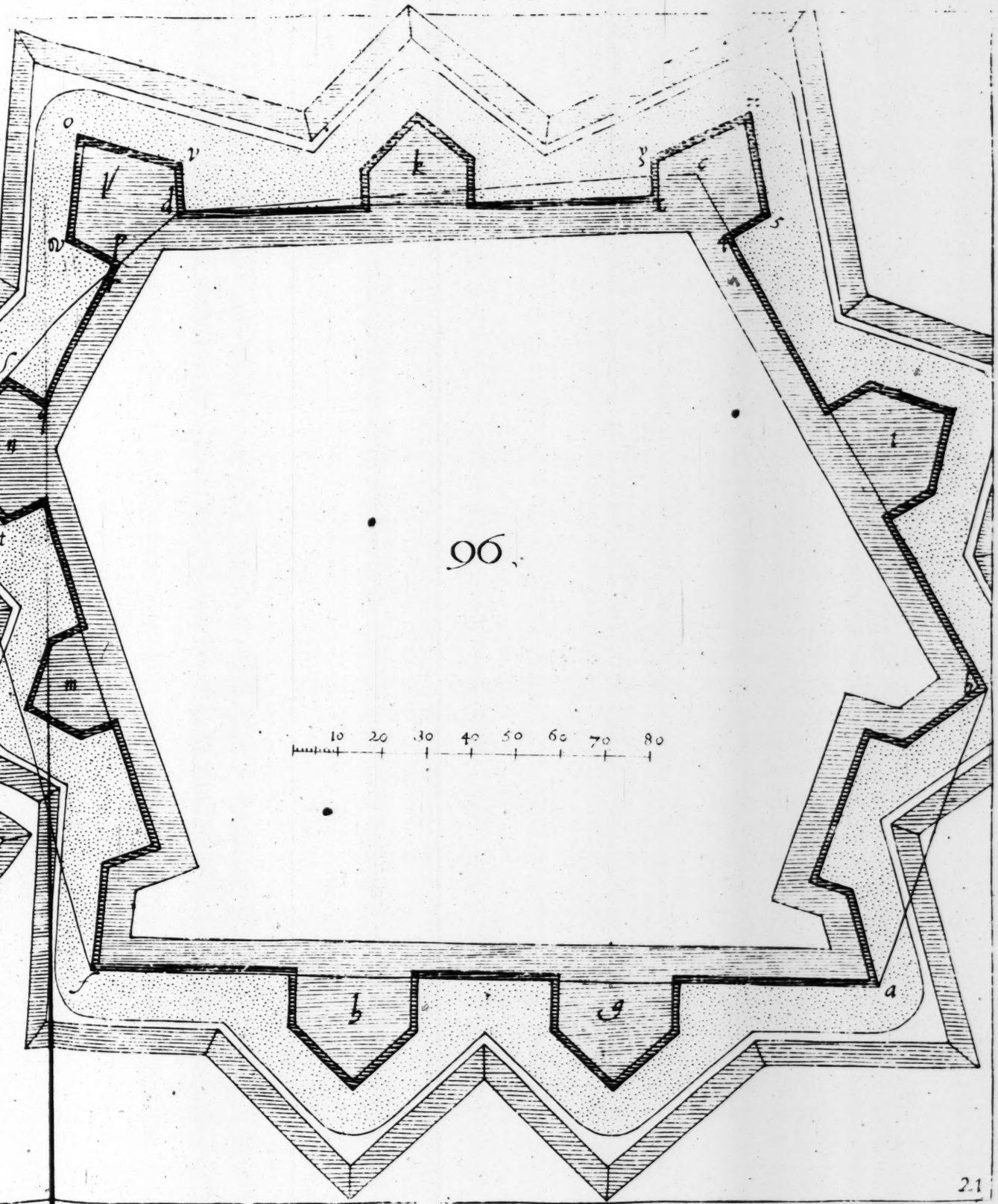


Marlois. S.

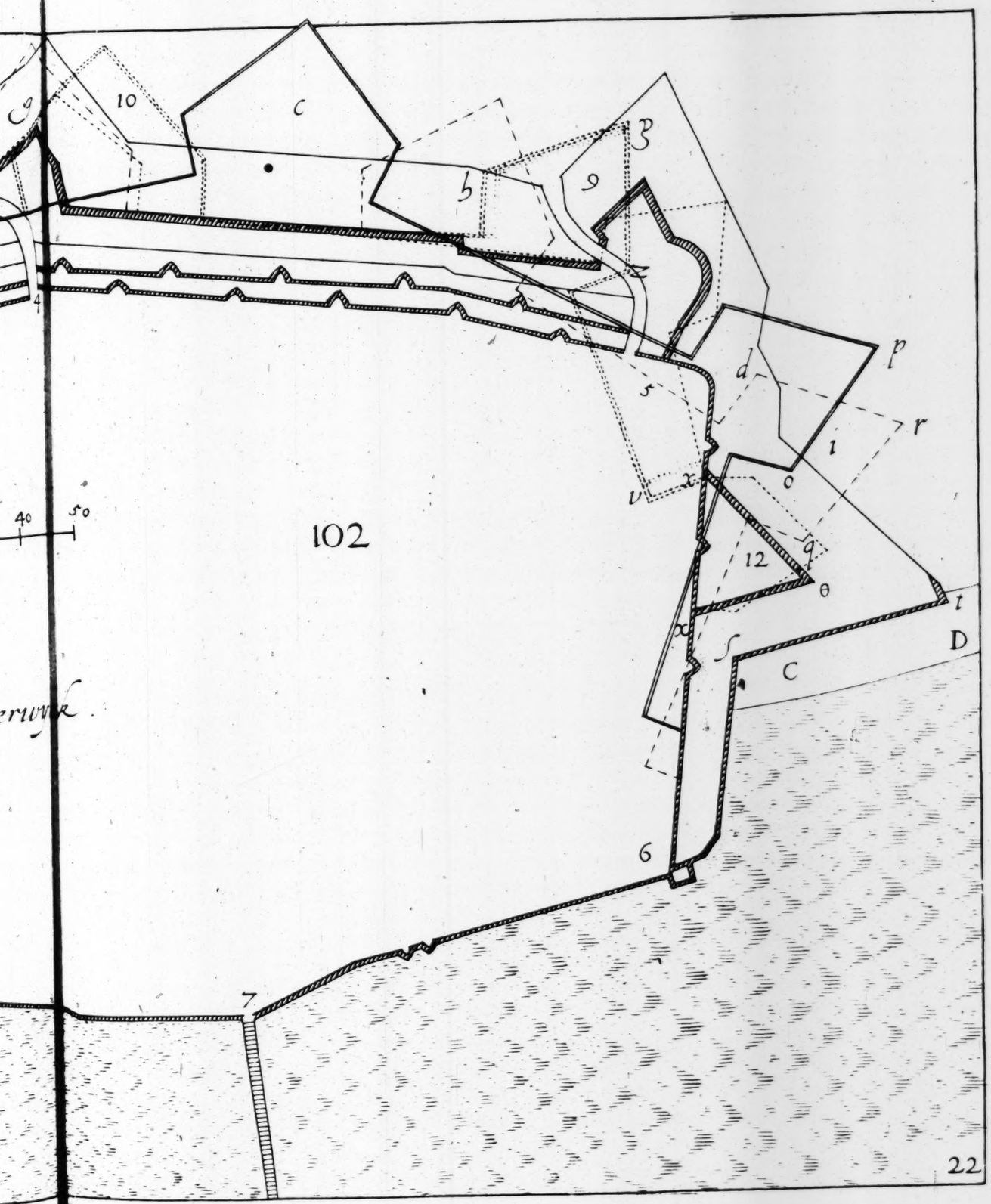

f
g
b
G
H
c
B
93.
a
d
b
e
i
94.
k
i
b
e
d
c
10
20
30
40

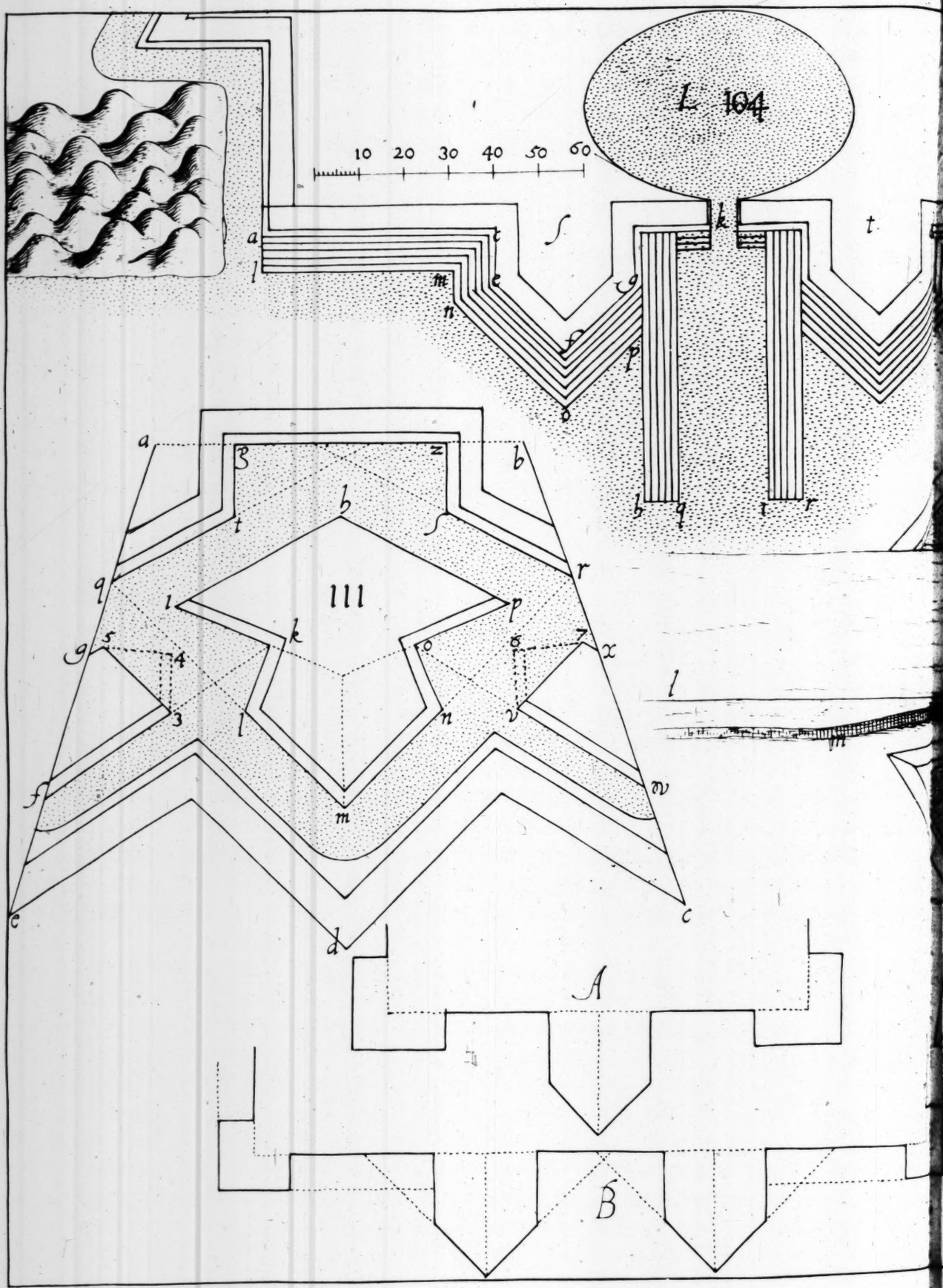

10 20 30 40 50
92.
a b c d e f g h i k l m n o p q r s t x y z
30 40 50 60 70

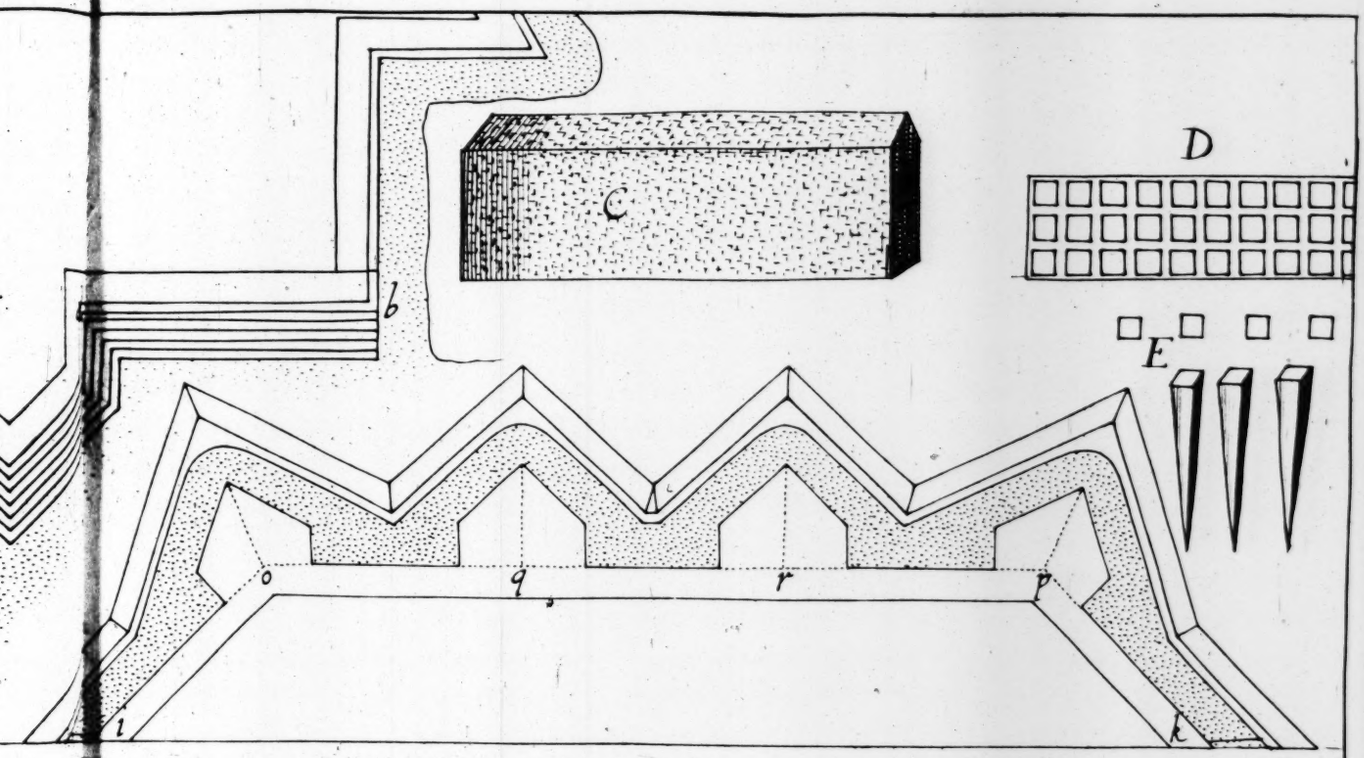

97
98
99
100
101
95.
k
114 k
d
c
b
a
f
i
132
124
170
10 20 30 40 50 60 70 80


96.
10 20 30 40 50 60 70 80

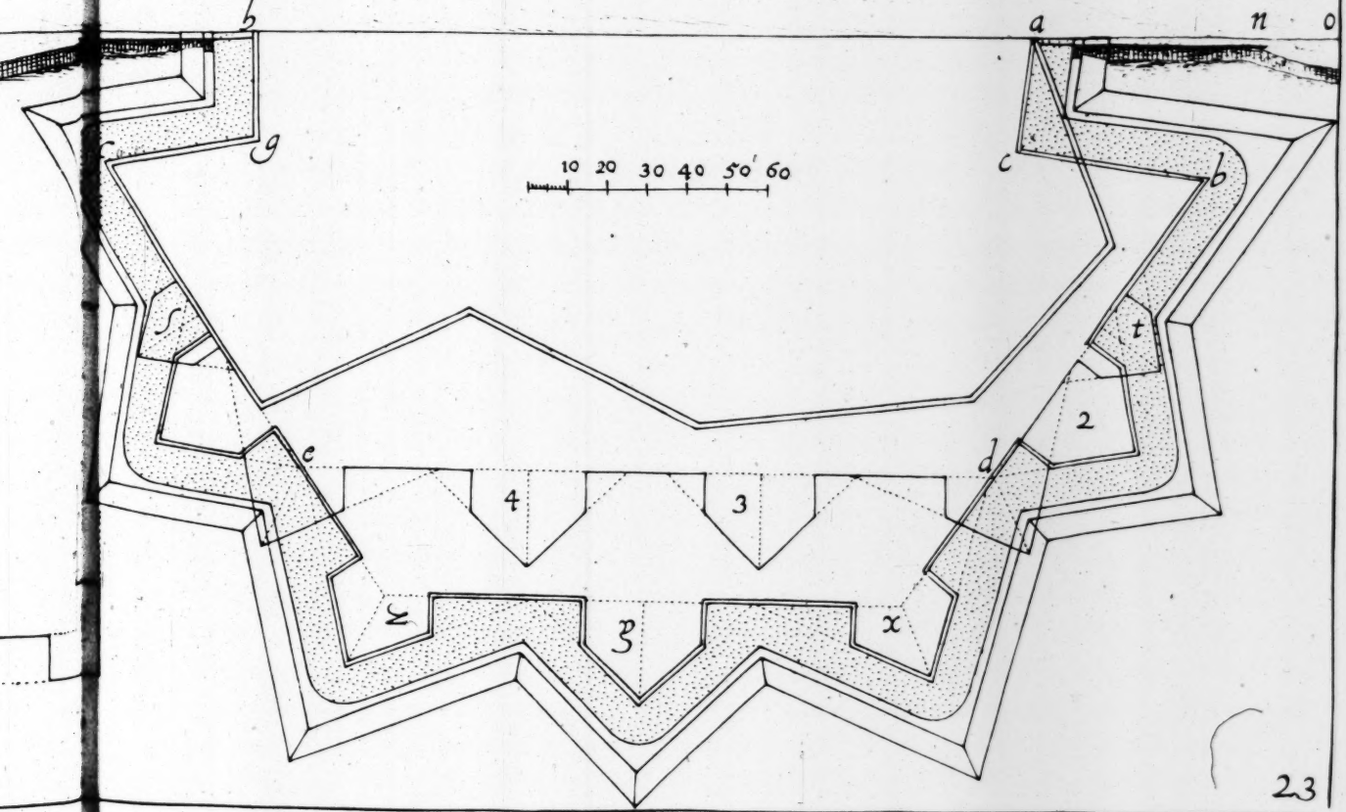

g
h
b
f
4
3
5 10 20 30 40
c a
2
Herderwyk
8
1


9
10
c
b
9
β
d
p
r
i
o
x
v
s
40
50
102
12
θ
q
t
D
C
6
7
22

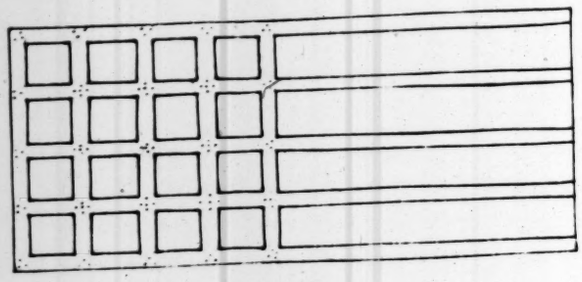

L. 104
10 20 30 40 50 60
a
l
m
n
o
p
q
r
s
t
k
111
A
B



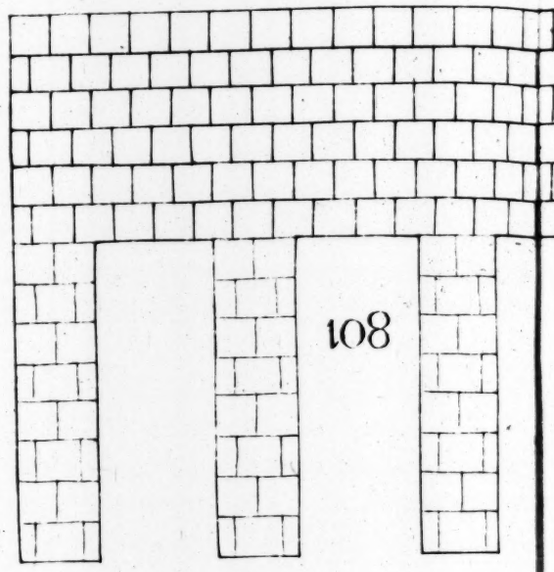
103



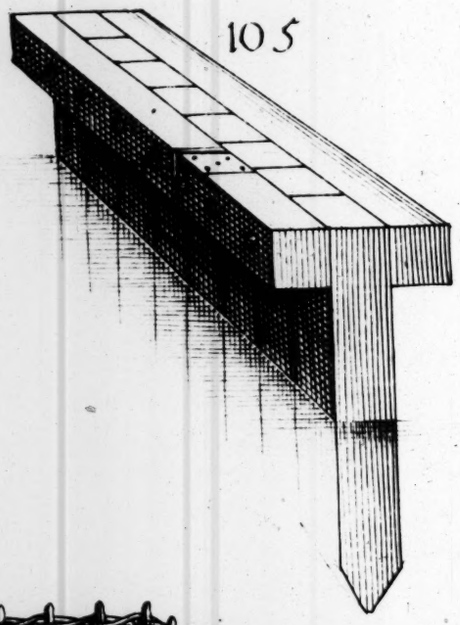
23



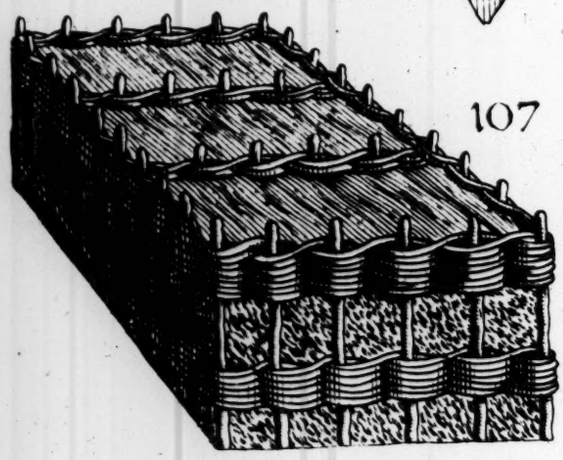
109



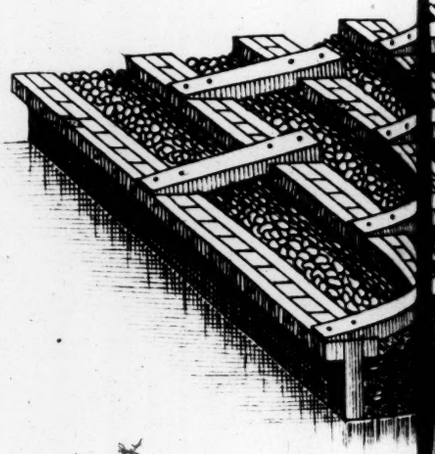
108

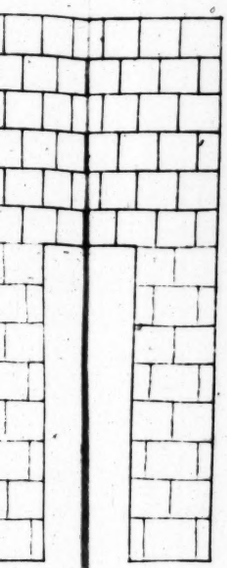


105

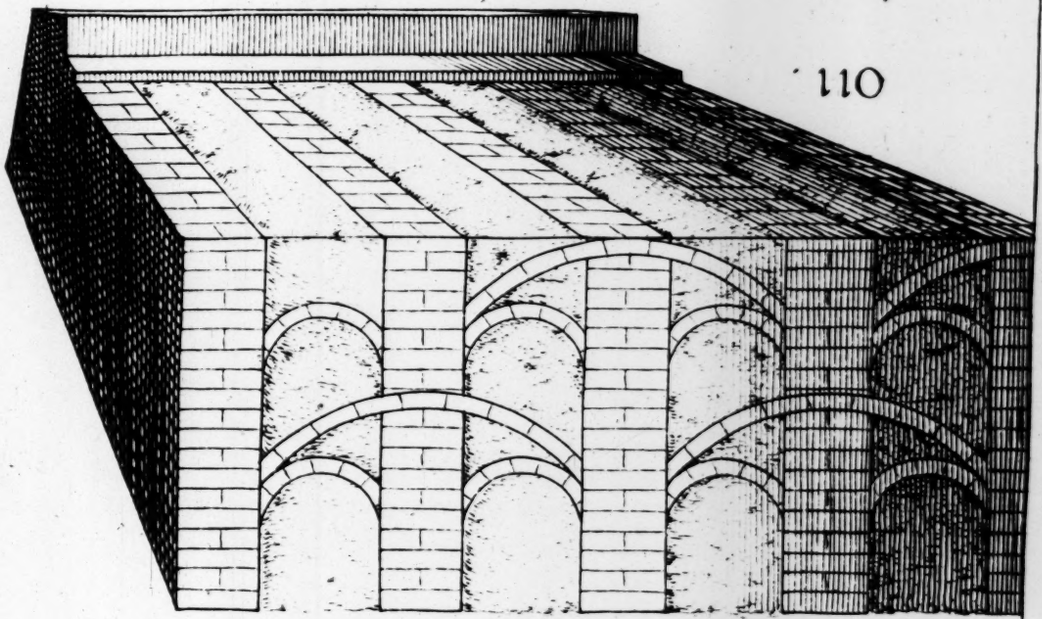


107

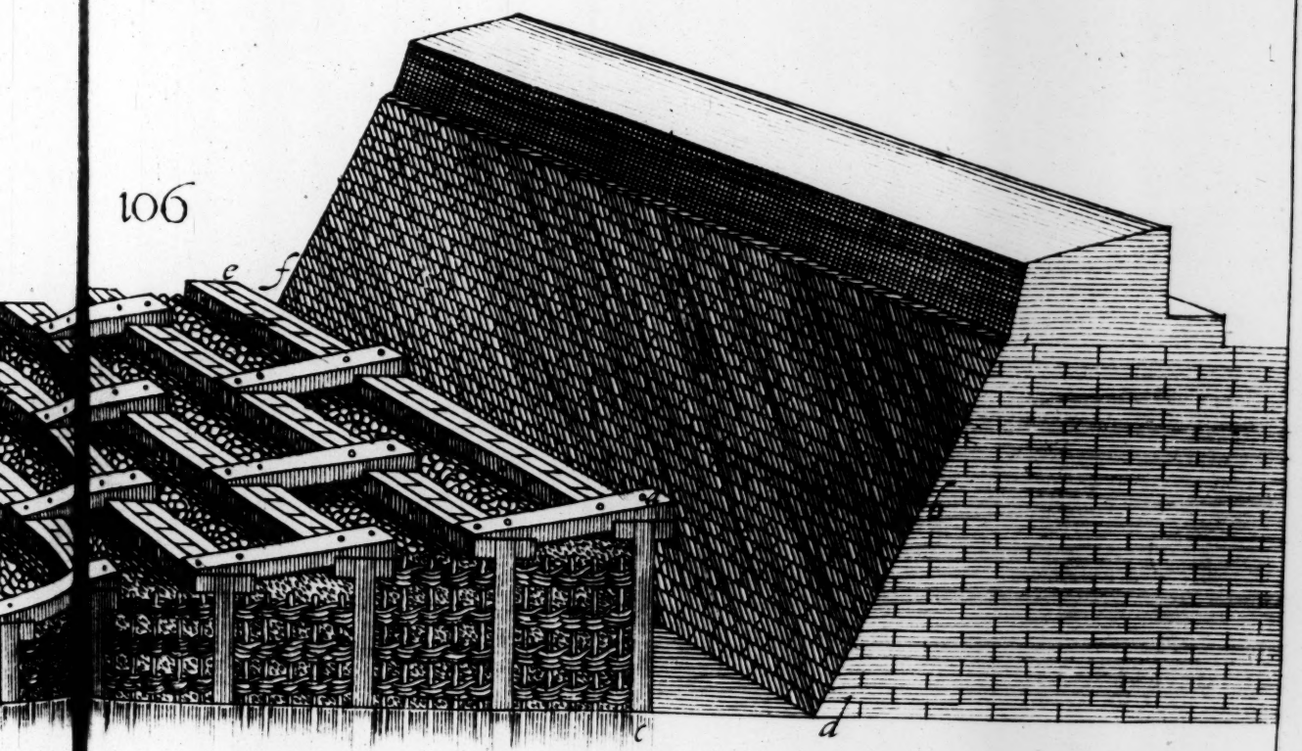


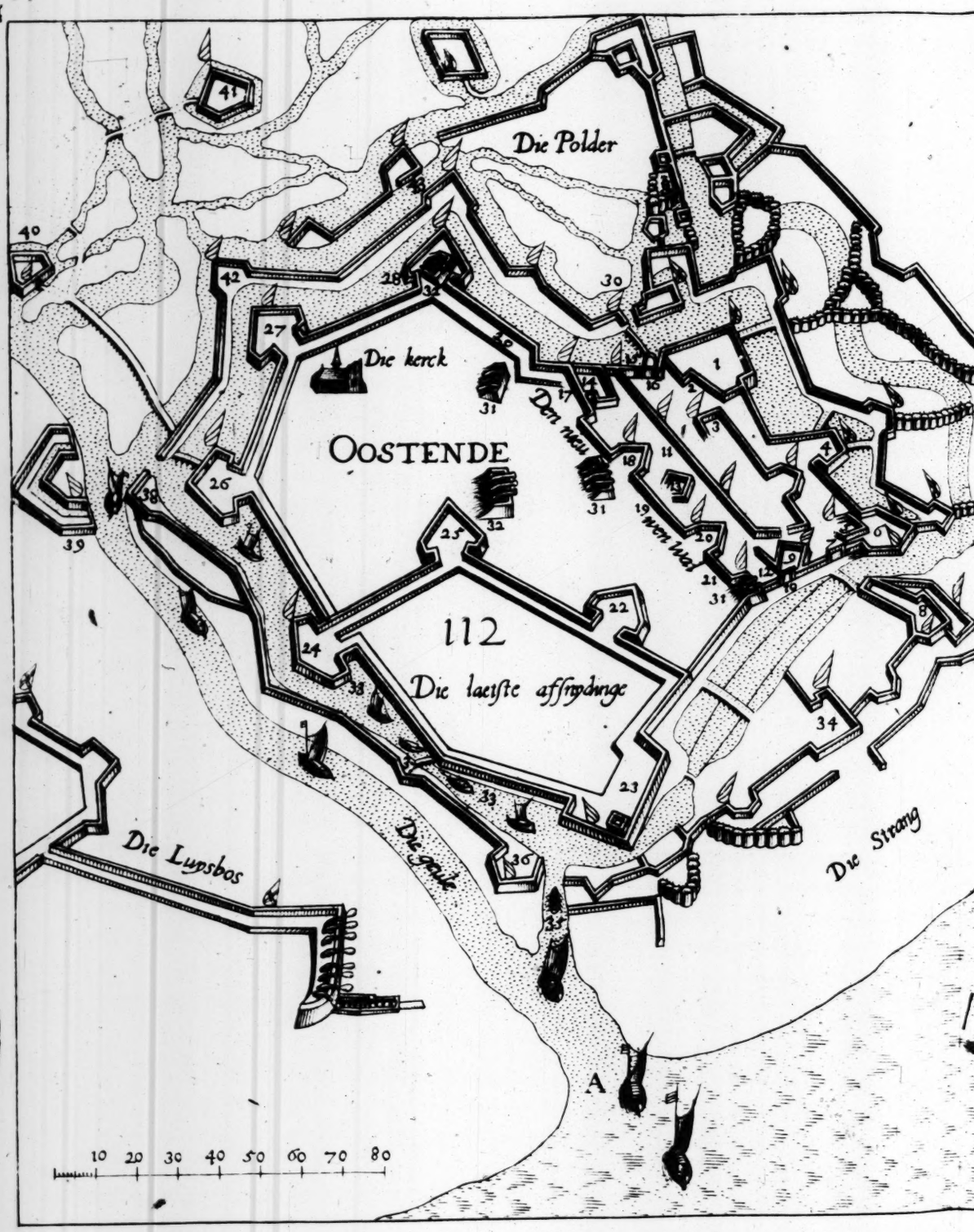


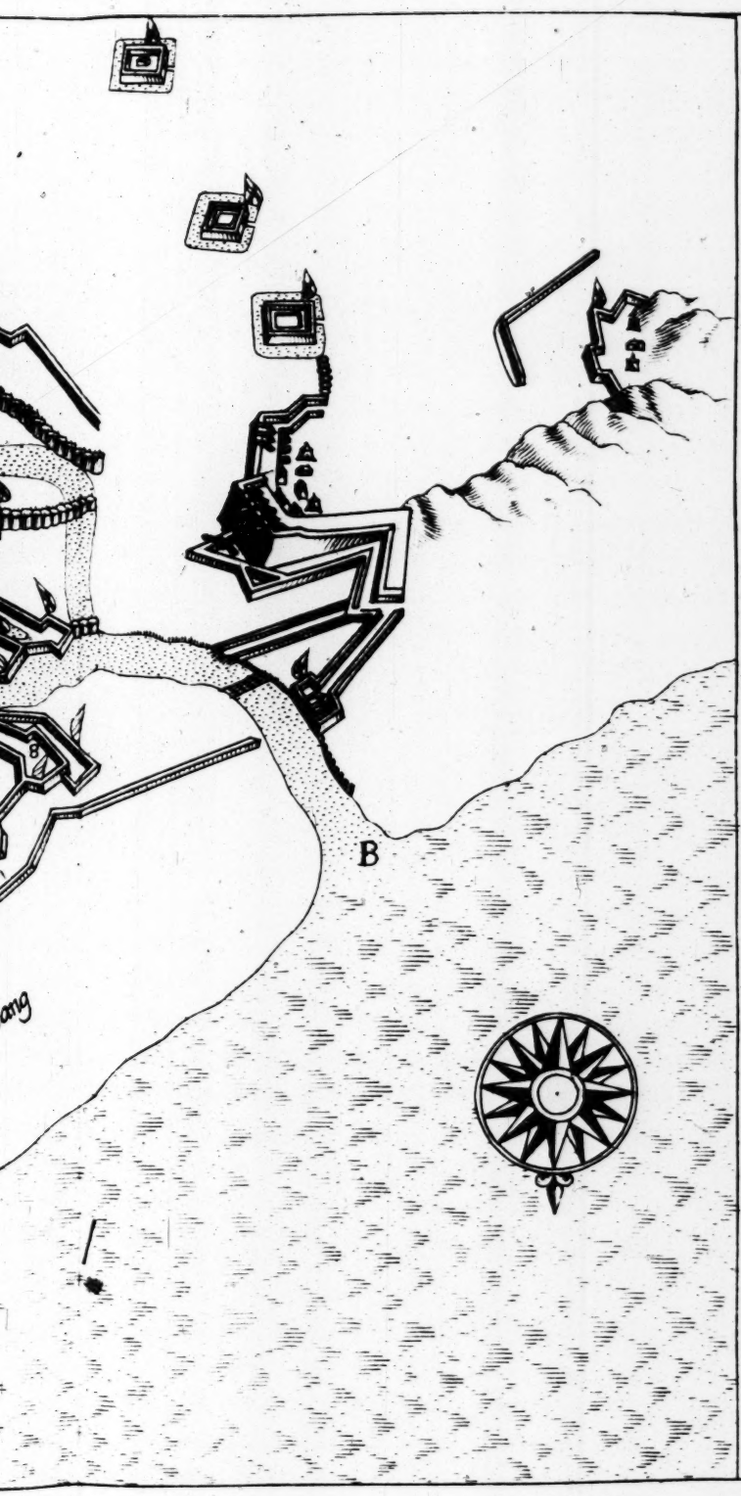
110



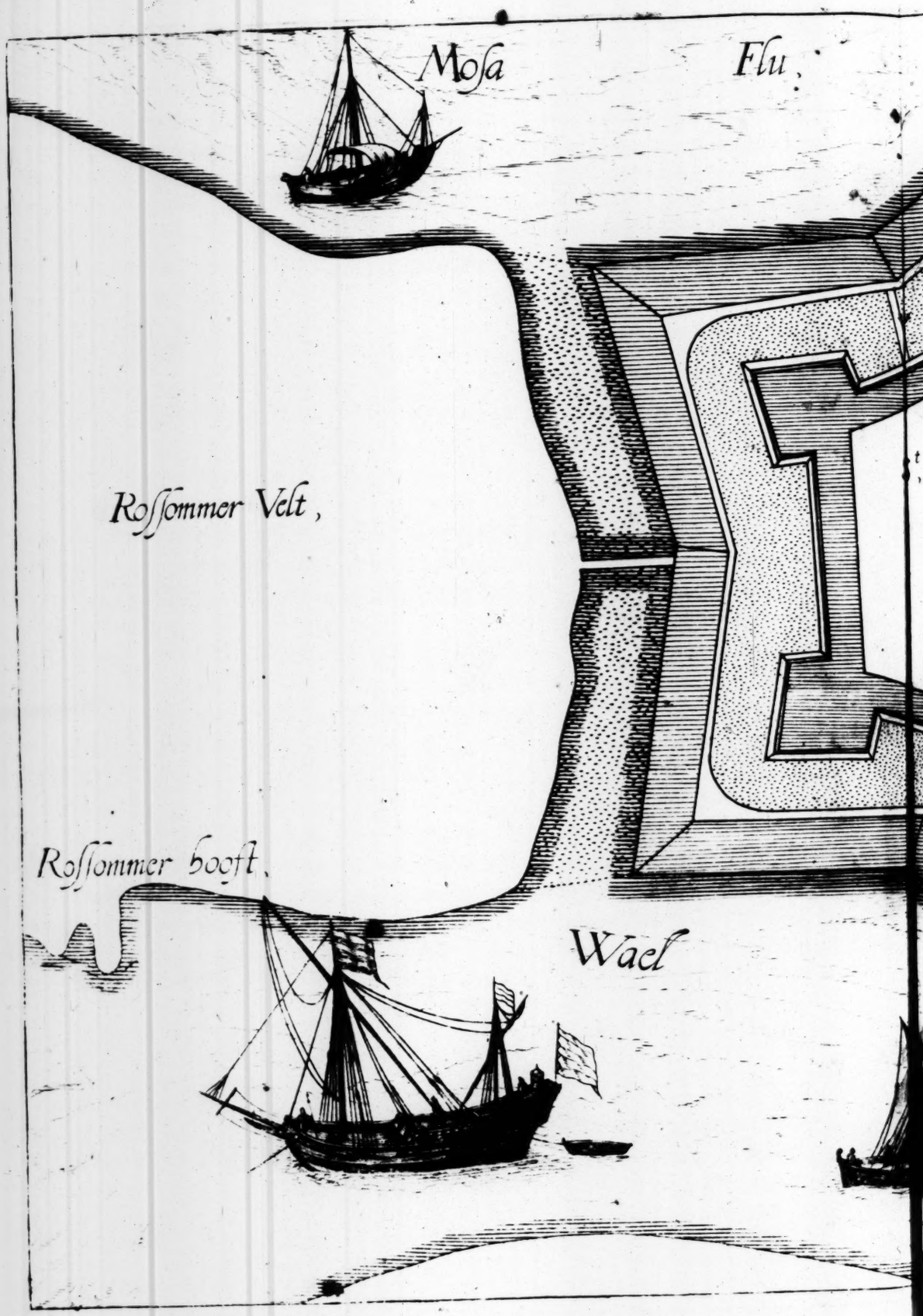
106

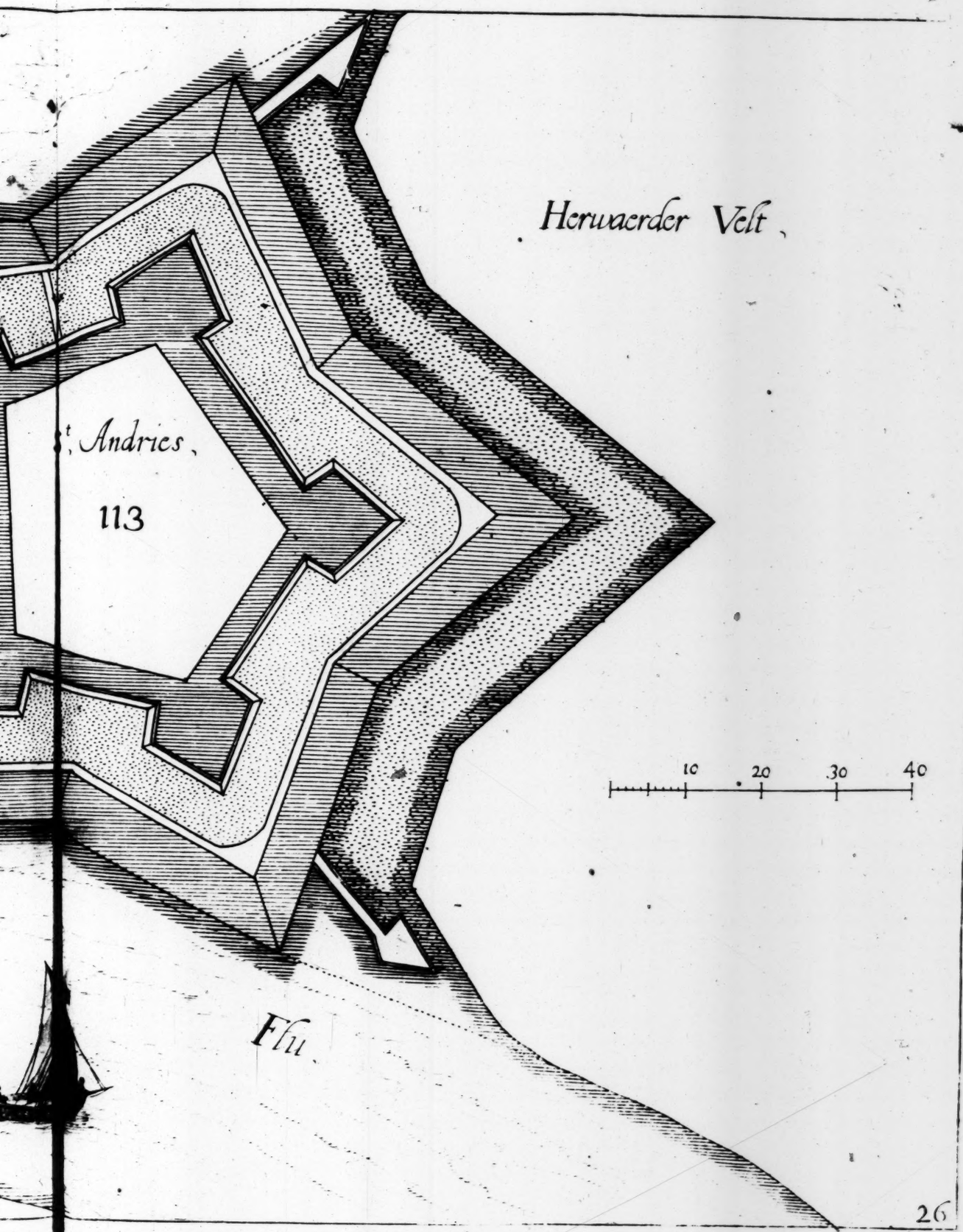



Die Polder
Die kerck
OOSTENDE
Den Tuell
Die laeiste affspringe
Die Lupsbos
Die gaule
Die Strang
A
10 20 30 40 50 60 70 80

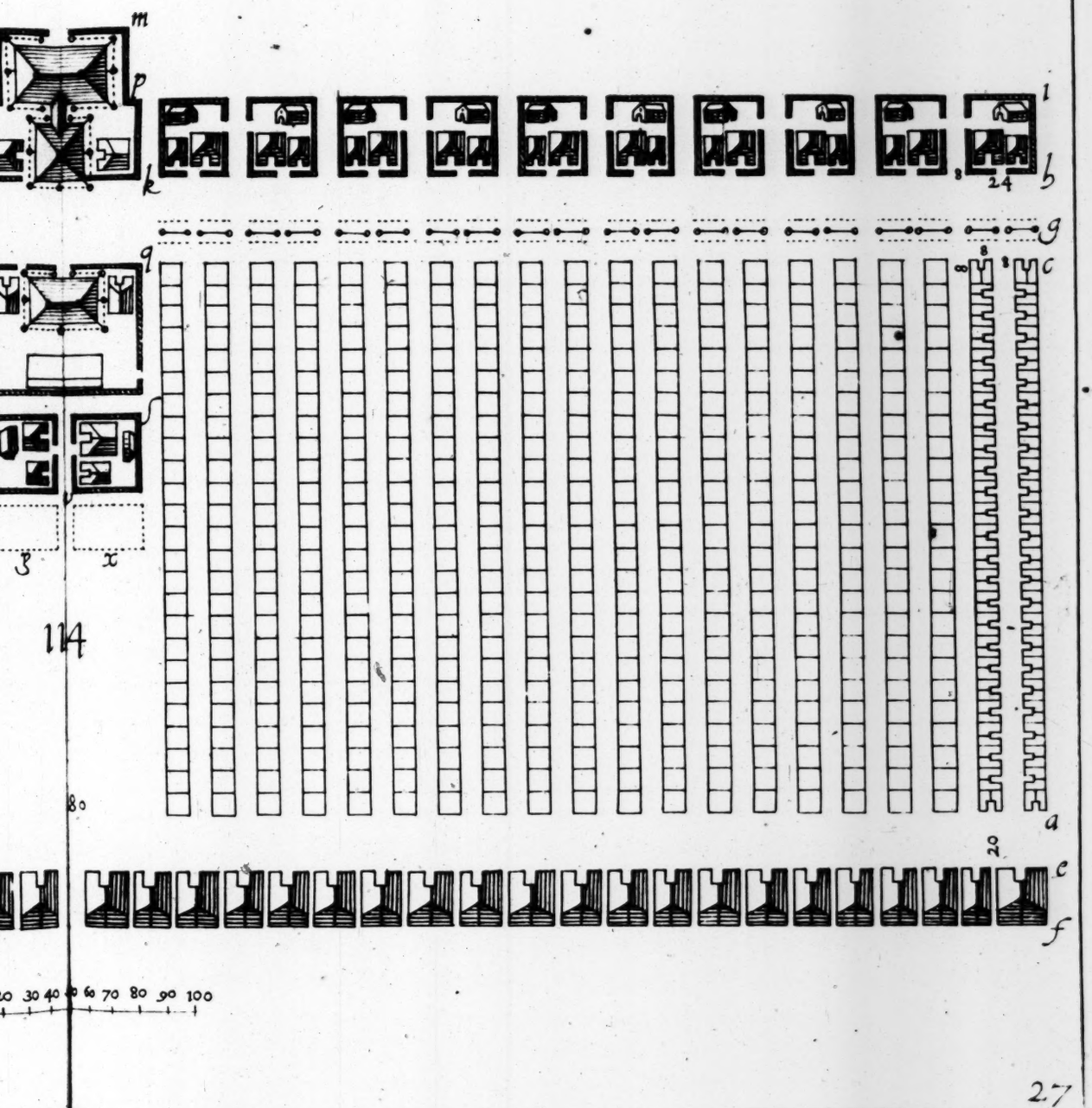


1. De oude polder.
2. Cassemat.
3. Het nieuwe west ravelyn.
4. De west poort.
5. Nieu porcspic.
6. Helmont.
7. De oude Sluis.
8. Santbil.
9. Halve maen so booch als de wal.
10. Slupseerst gemaeckt om t'water inde graft
11. Trencement. te setten.
12. Bolwerck.
13. Contrescherp.
14. Halve maen.
15. Een Slupseerst gemaeckt.
16. Sorte nae de polder halve maen.
17. Eee Sorte.
18. Nieu polder.
19. Sorte.
20. Nieu helmont.
21. Sorte.
22. Nieu west poort.
23. Vlammenburch.
24. Peeckels bolwerck.
25. Nieu Polder.
26. Spaens bolwerck.
27. Koestal, oft Supt oost bolwerck.
28. Supt bolwerck oft Treurenburch
29. De vrygaerden.
30. Polder halve maen.
31. Baterie.
32. Catte.
33. Hier leggen de Schepen.
34. Nieu Santbil daer de oude kerck plach te staen
35. Nieuwe haven.
36. Noortwest bolwerck.
37. De oost poort en het ravelyn.
38. Oost ravelyn.
39. Spaens halve maen.
40. Slimmers halve maen.
41. Elcks vendriet.
42. Supt oost ravelyn.
43. Supt ravelyn.

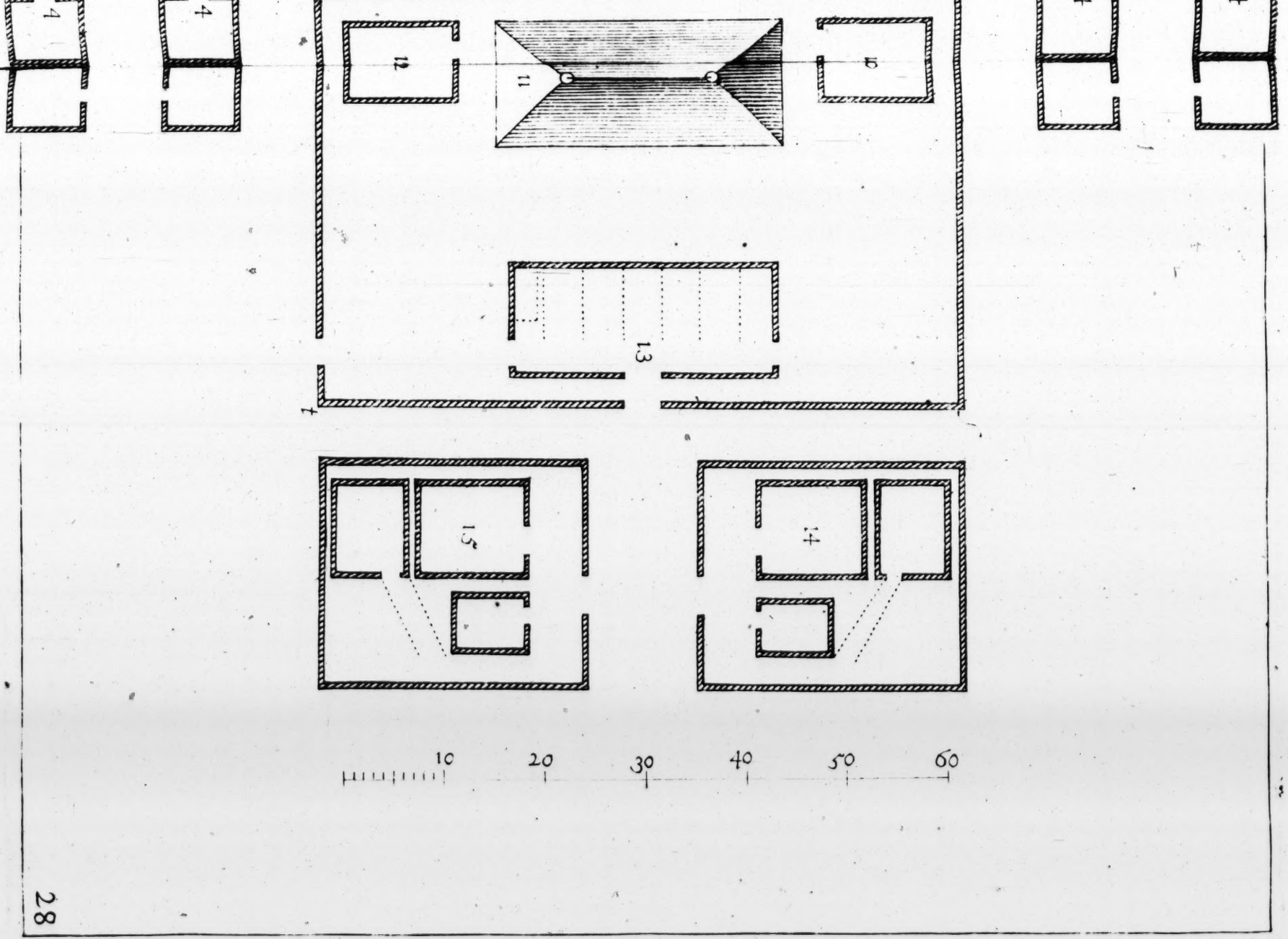

Mosa
Flu,
Rossommer Velt,
Rossommer hooft,
Wael

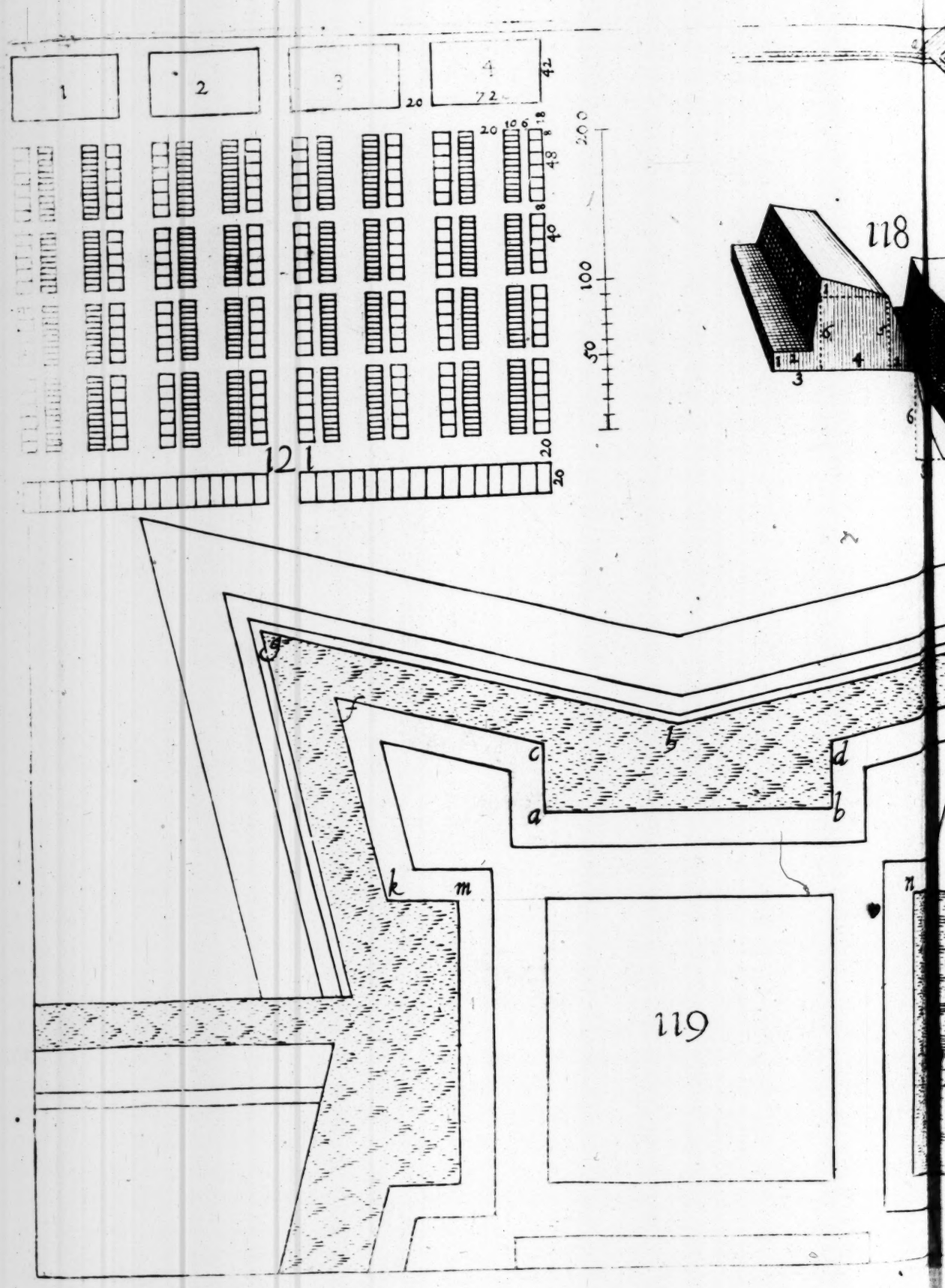

Herwaerder Velt
t. Andries
113
10
20
30
40
Flu

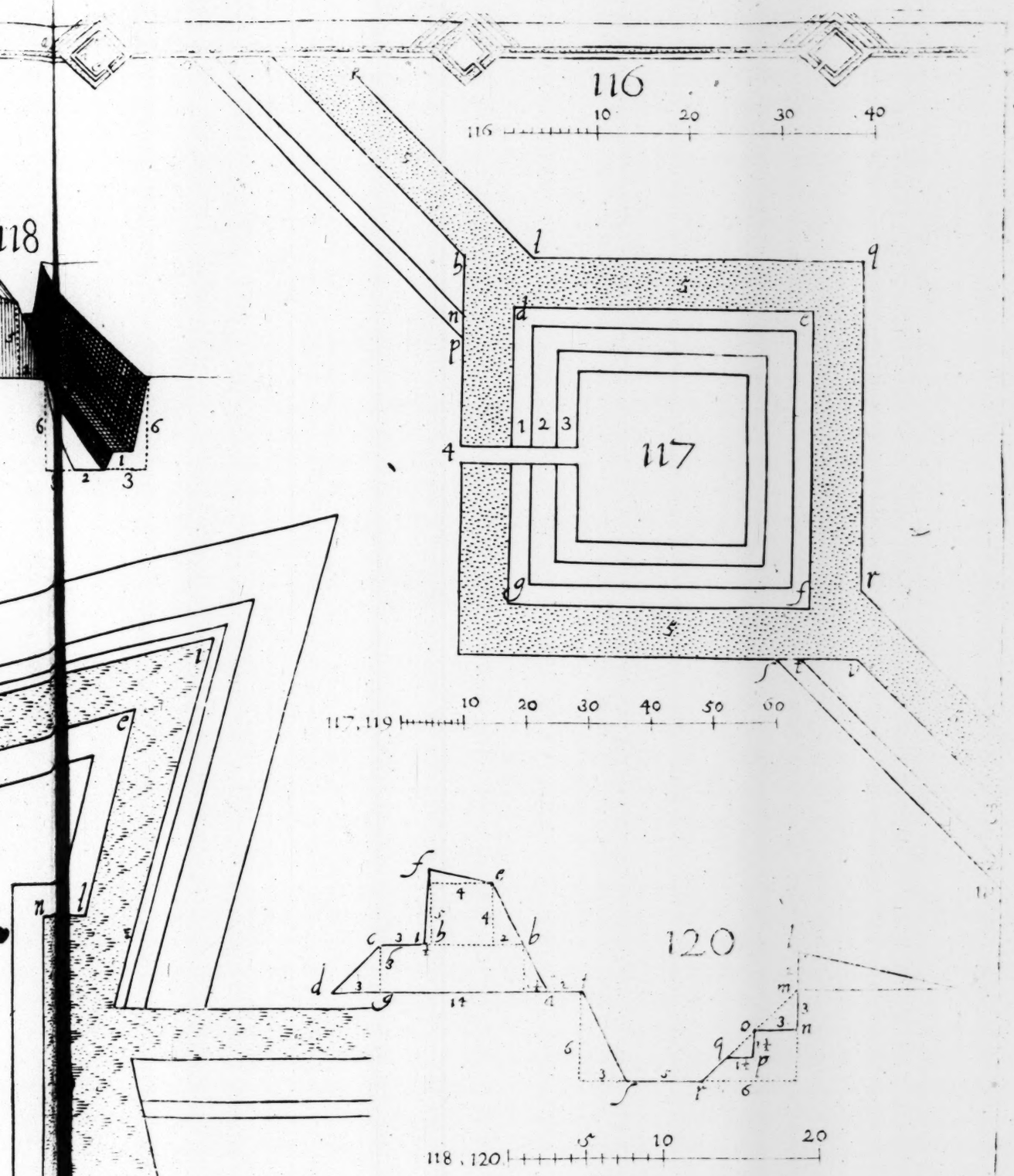
n
o
l
d
r
t
z
b
10 20 30 40

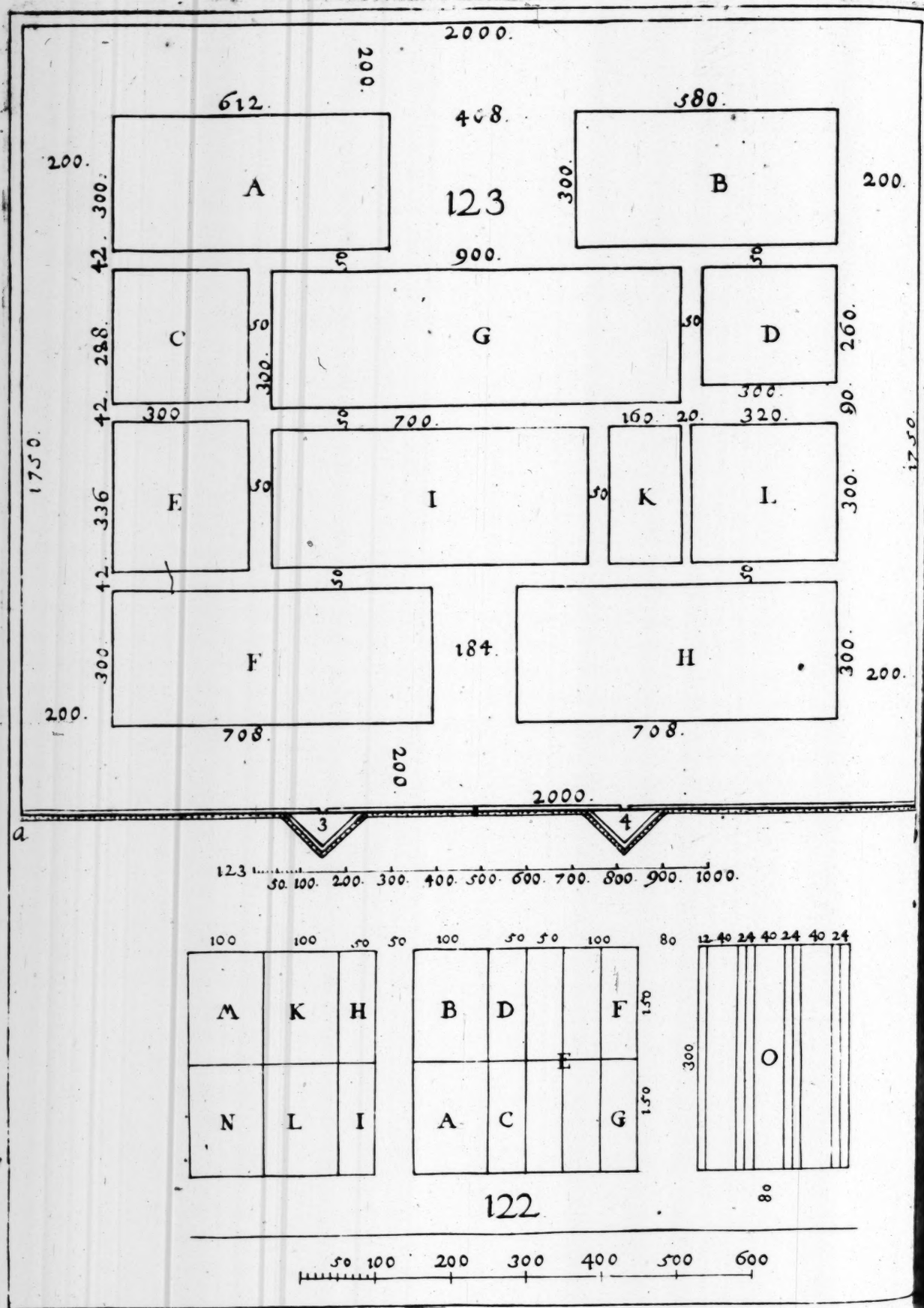

m
p
k
l
b
24
g
q
c
8
a
20
e
f
y
x
114
80
20 30 40 60 70 80 90 100
27

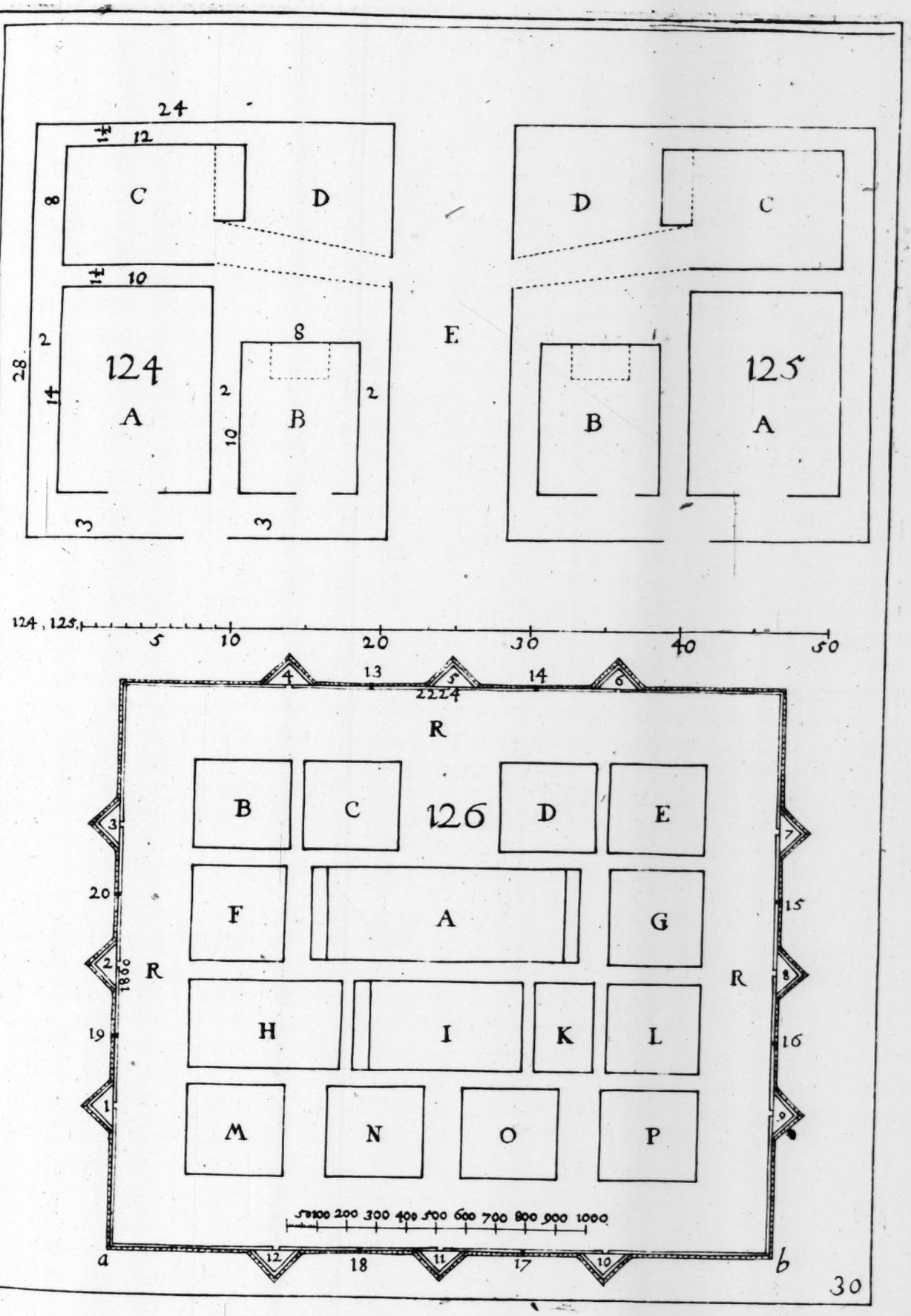
2
16
4
4
k
m
p
6
8
5
9
7
n
o
l
q
r
115
17
3
4
4

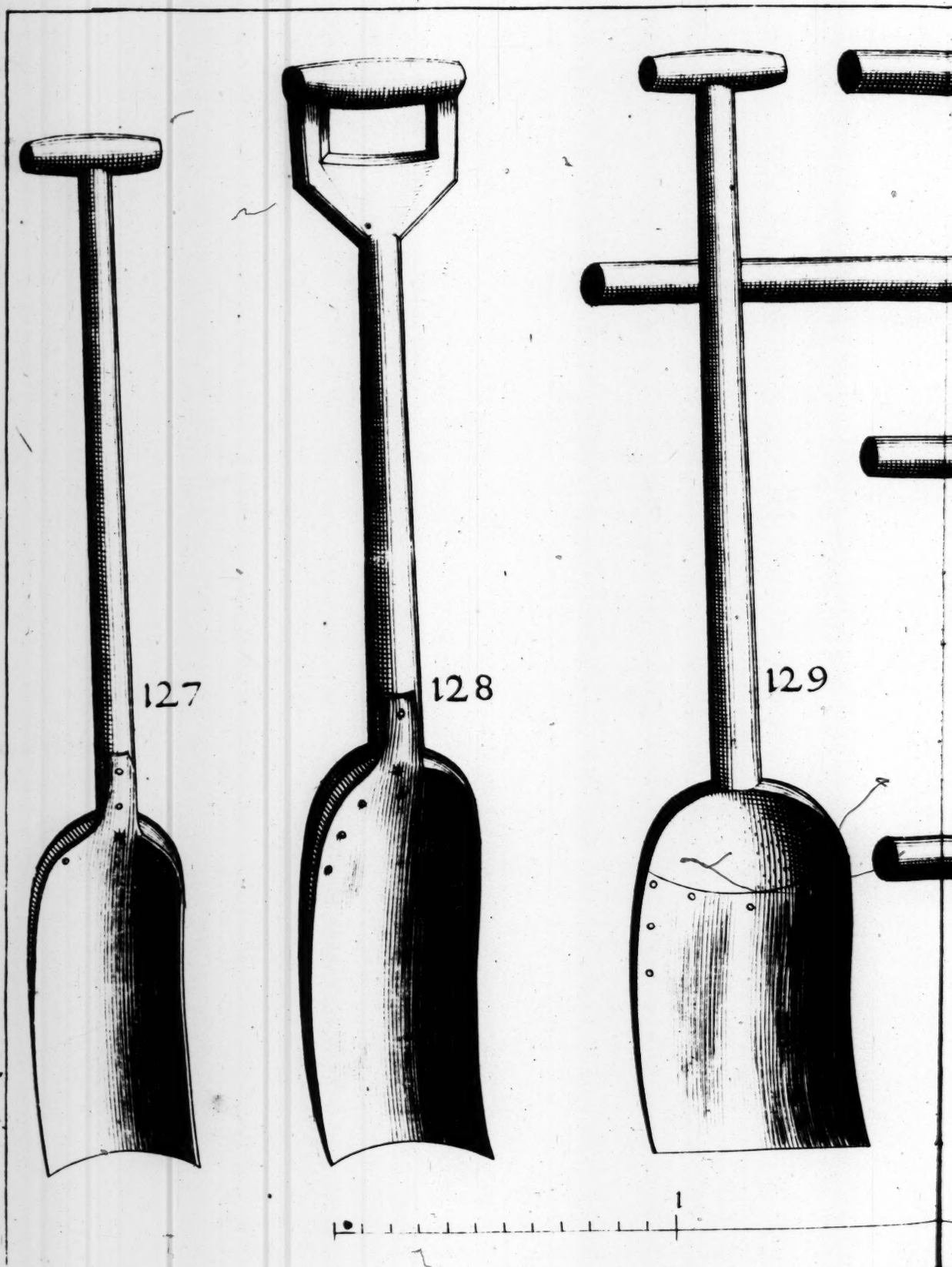

4
4
12
11
10
13
15
14
10
20
30
40
50
60

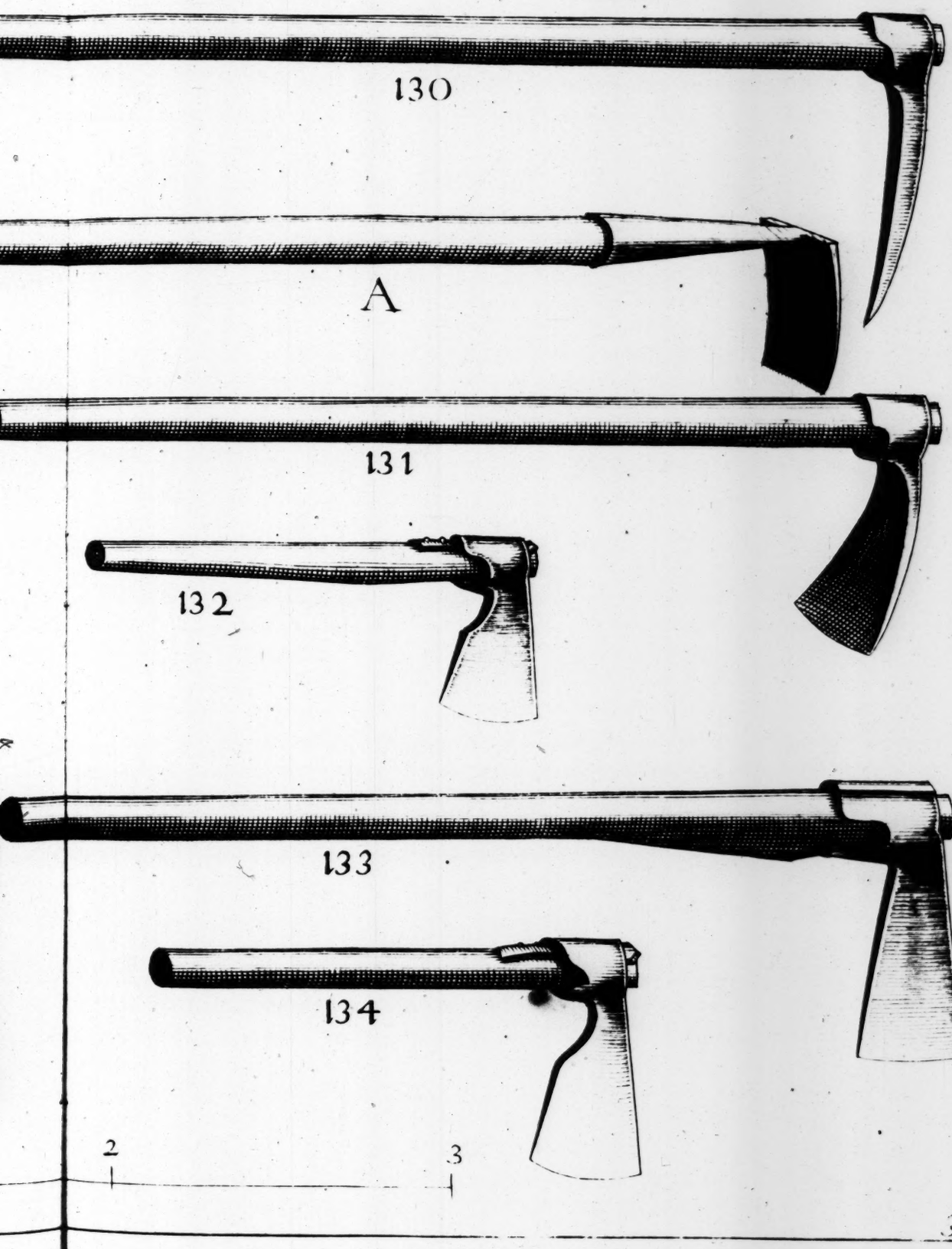

1
2
3
4
72
42
20
48
40
200
100
50
121
118
119
a
b
c
d
e
f
g
k
m
n

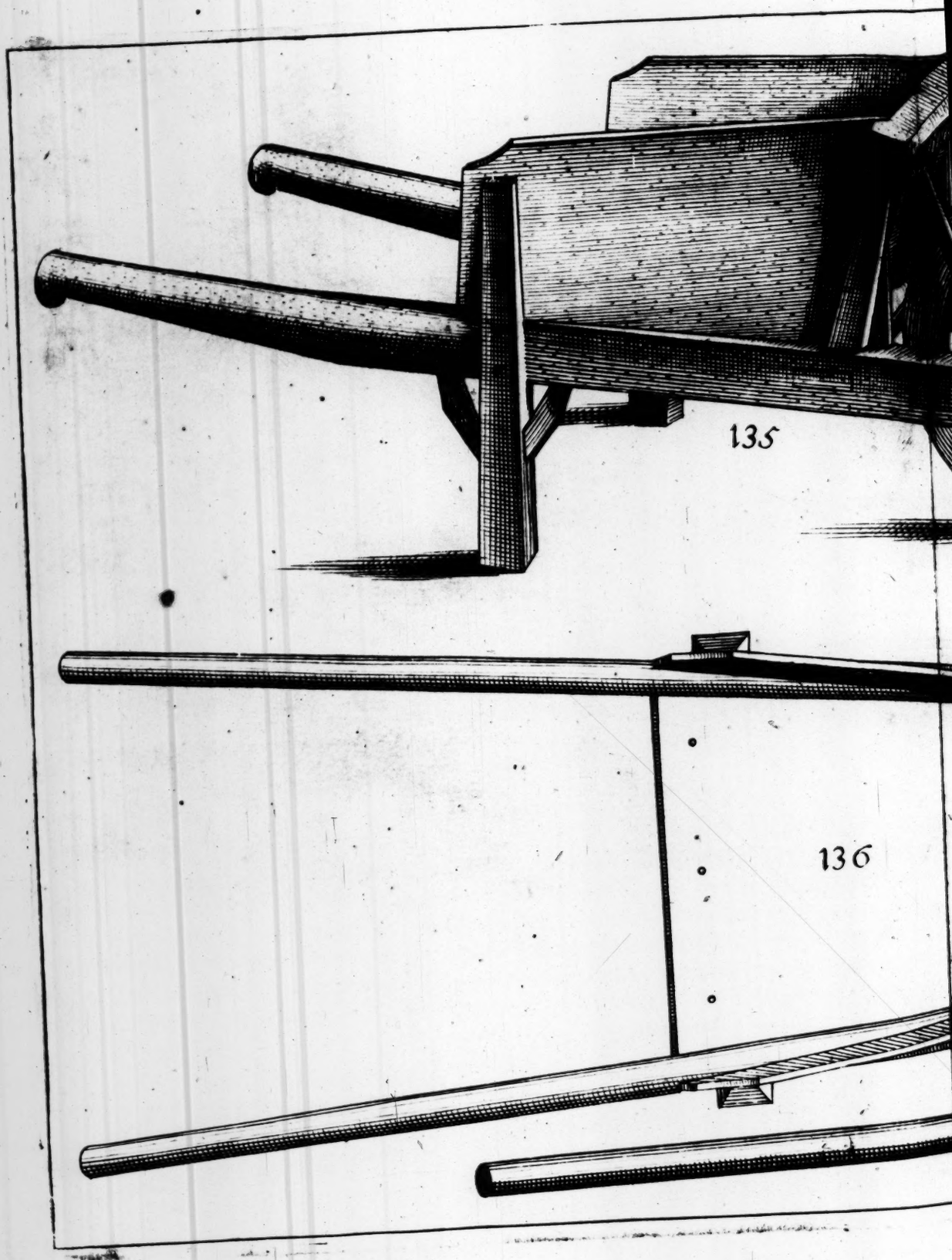

116
10 20 30 40
116
118
117
117, 119
10 20 30 40 50 60
120
118 . 120
5 10 20

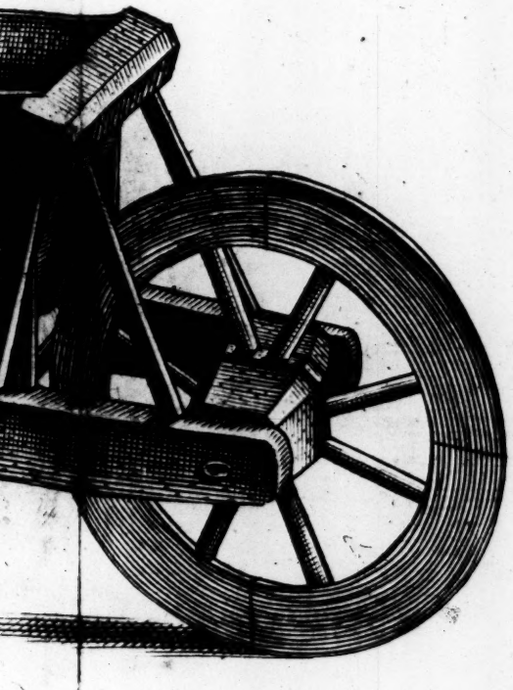

2000.
200.
612.
408.
580.
200.
A
123
B
200.
300.
42.
300.
900.
50
C
G
D
288.
320.
260.
300
700.
160
20.
320.
90.
1750.
E
I
K
L
336
300.
F
184.
H
708.
708.
200.
2000.
a
3
4
123
50. 100. 200. 300. 400. 500. 600. 700. 800. 900. 1000.
100
50
80
12 40 24 40 24 40 24
M
K
H
B
D
F
O
N
L
I
A
C
G
E
150
122
50 100 200 300 400 500 600


24
12
C
D
8
10
124
A
B
2
14
28
3
E
D
C
125
A
B
124, 125,
5 10 20 30 40 50
13
14
2224
R
126
B
C
D
E
F
A
G
H
I
K
L
M
N
O
P
20
19
15
16
1800
50 100 200 300 400 500 600 700 800 900 1000
a
b
18
17
30


127
128
129
1


130
A
131
132
133
134
2
3

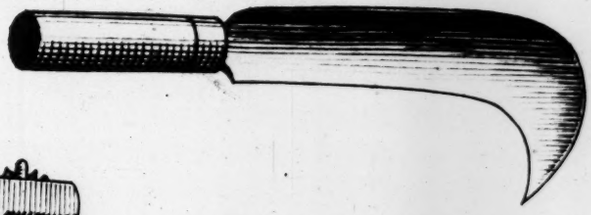

135
136

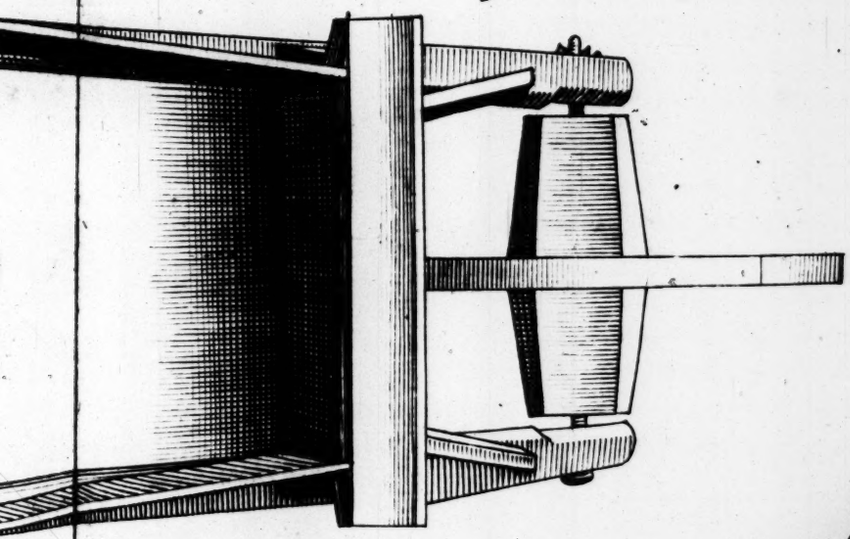


137

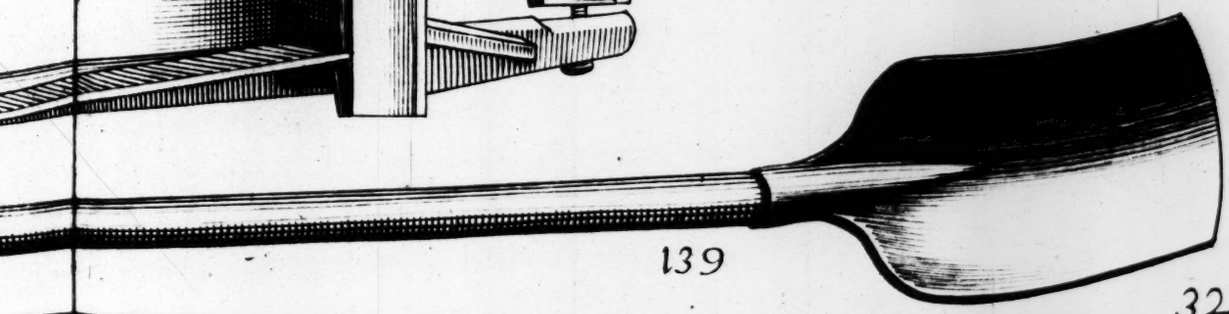


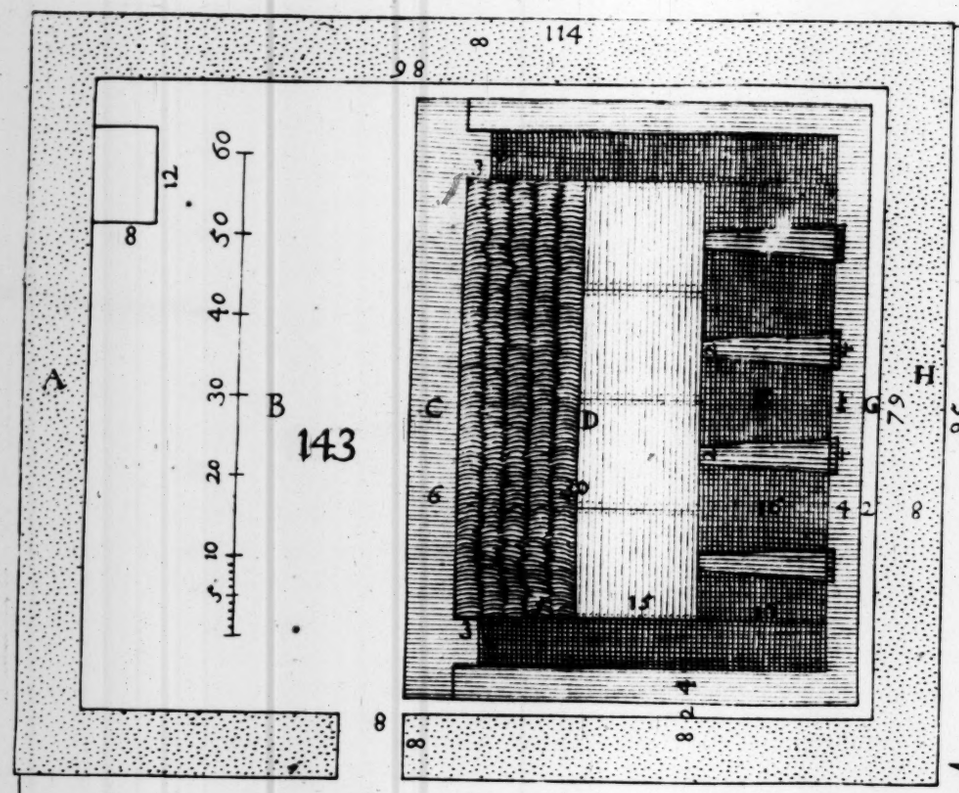
138



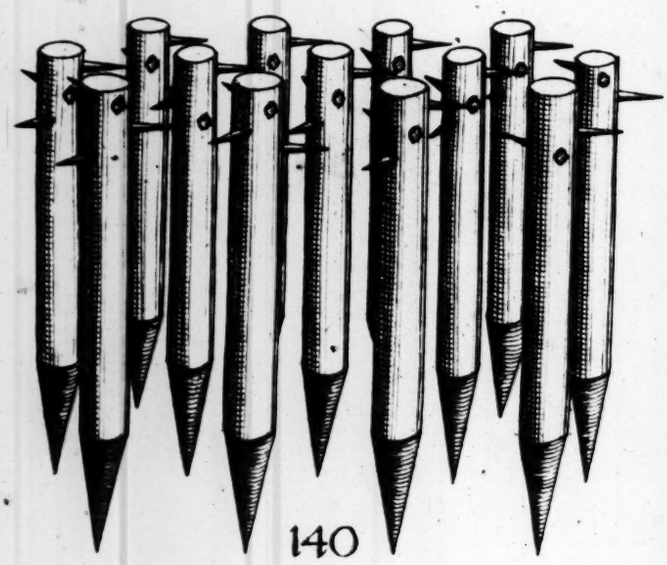


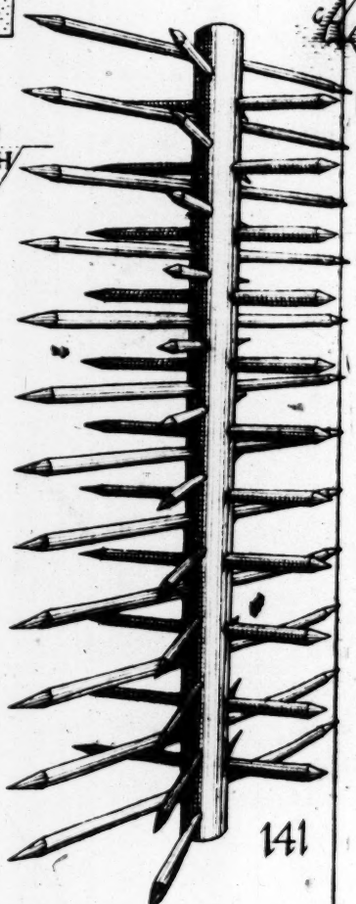
139

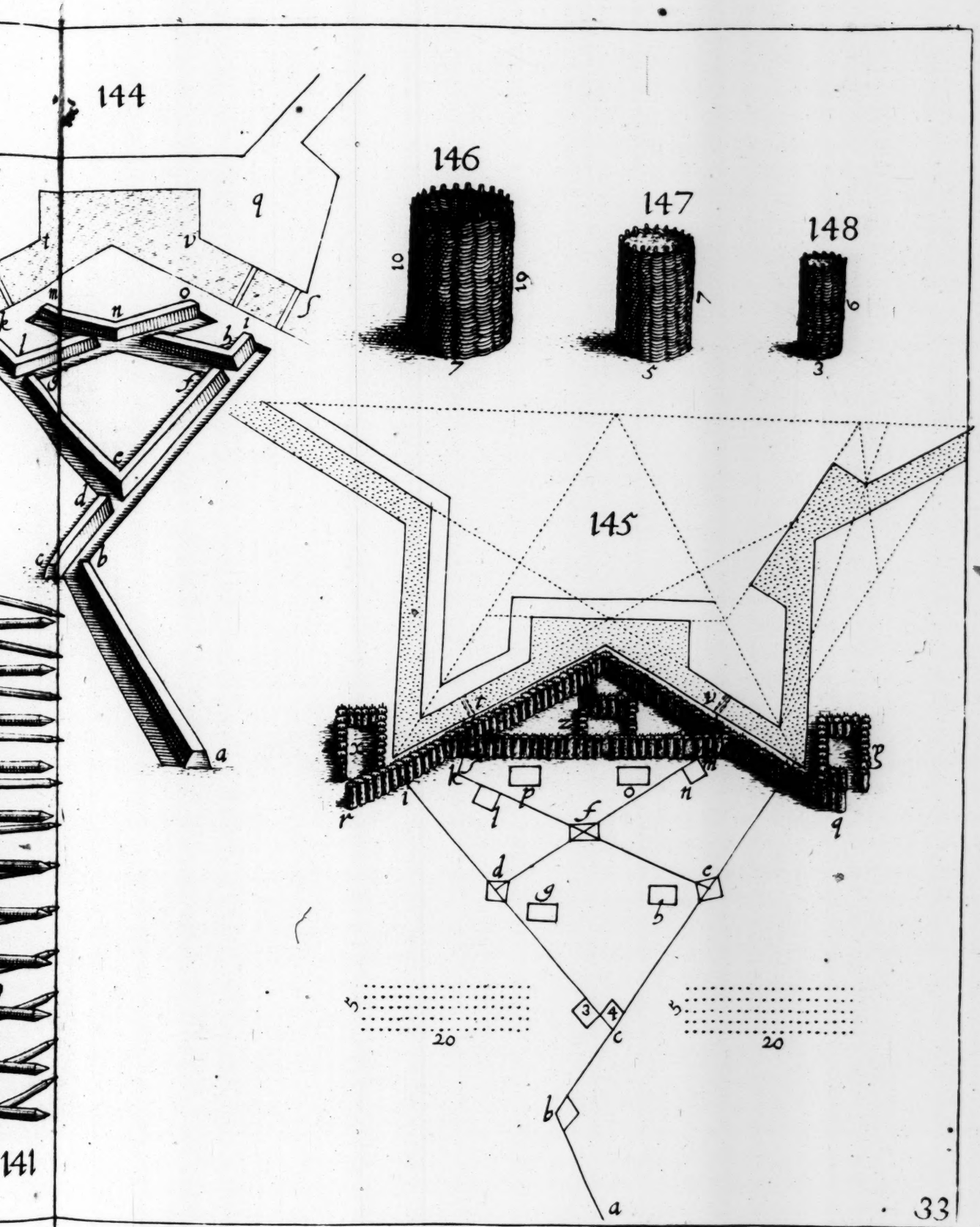



114
98
8
12
60
50
40
30
20
10
A
B
C
D
E
F
G
H
79
95
15
143

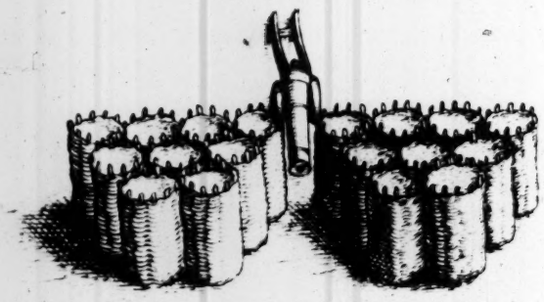

142
A
B
40
C
D
E
F
G
H
56
16
8

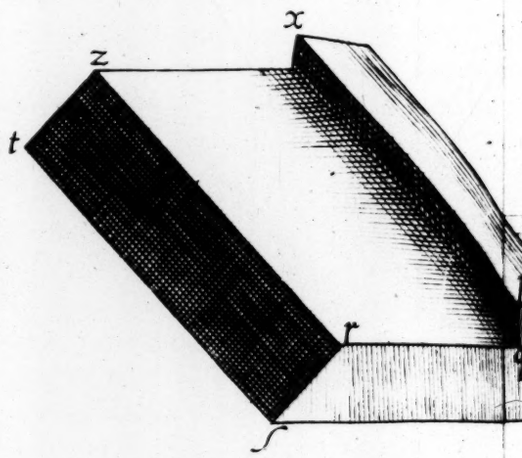

140


141

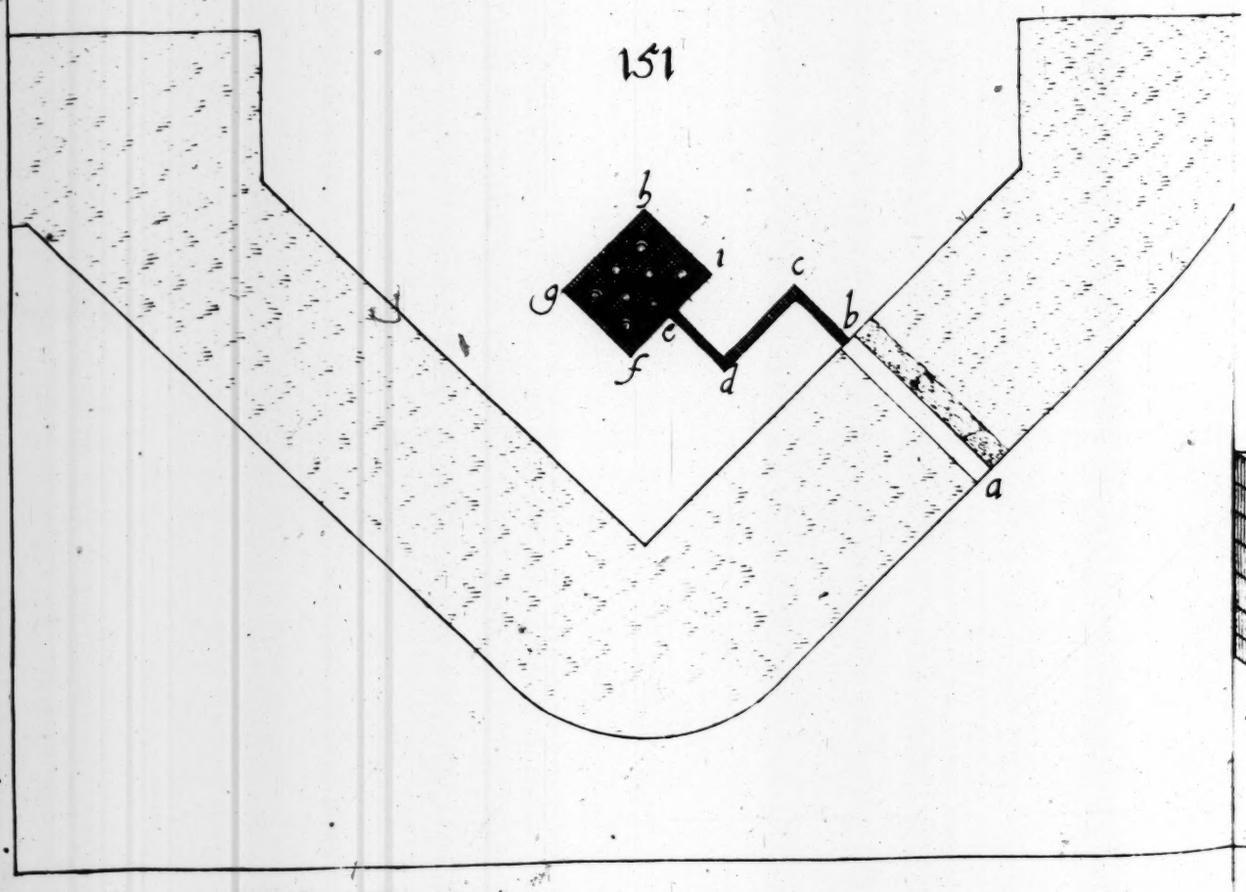

144
146
147
148
145
141
10
19
7
5
6
3
20
20

149

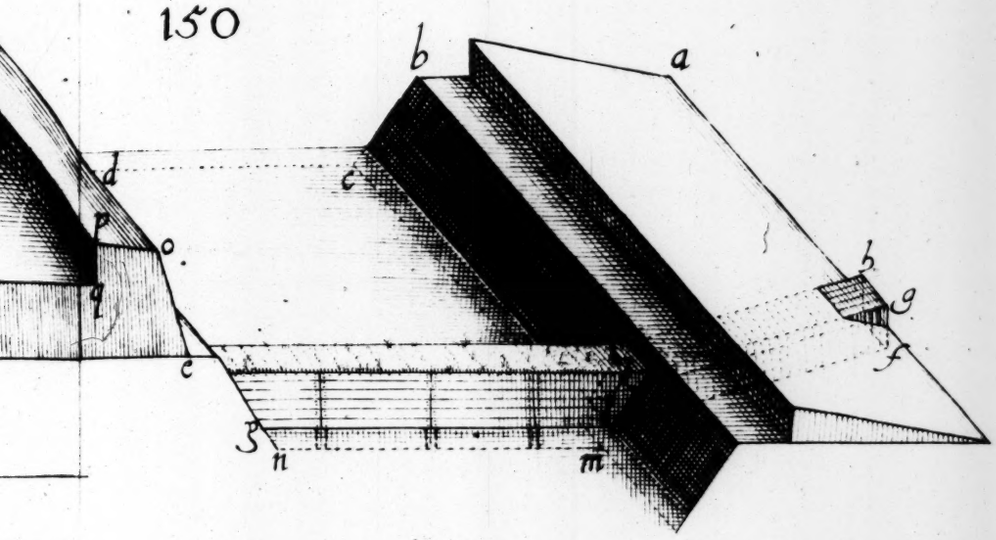




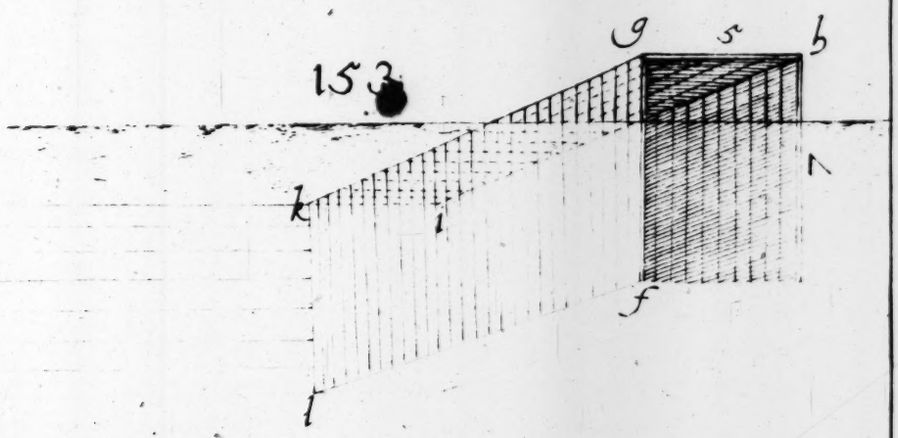
151

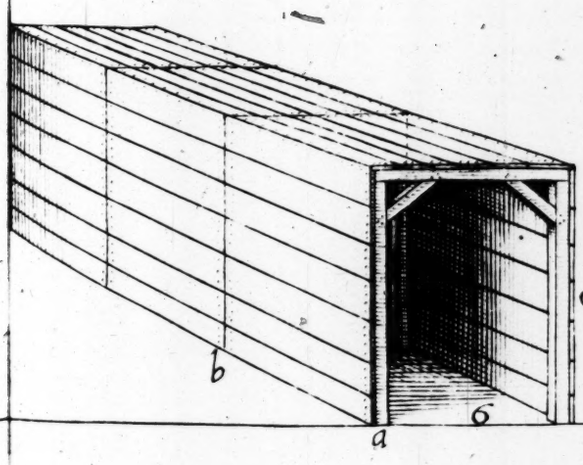


150

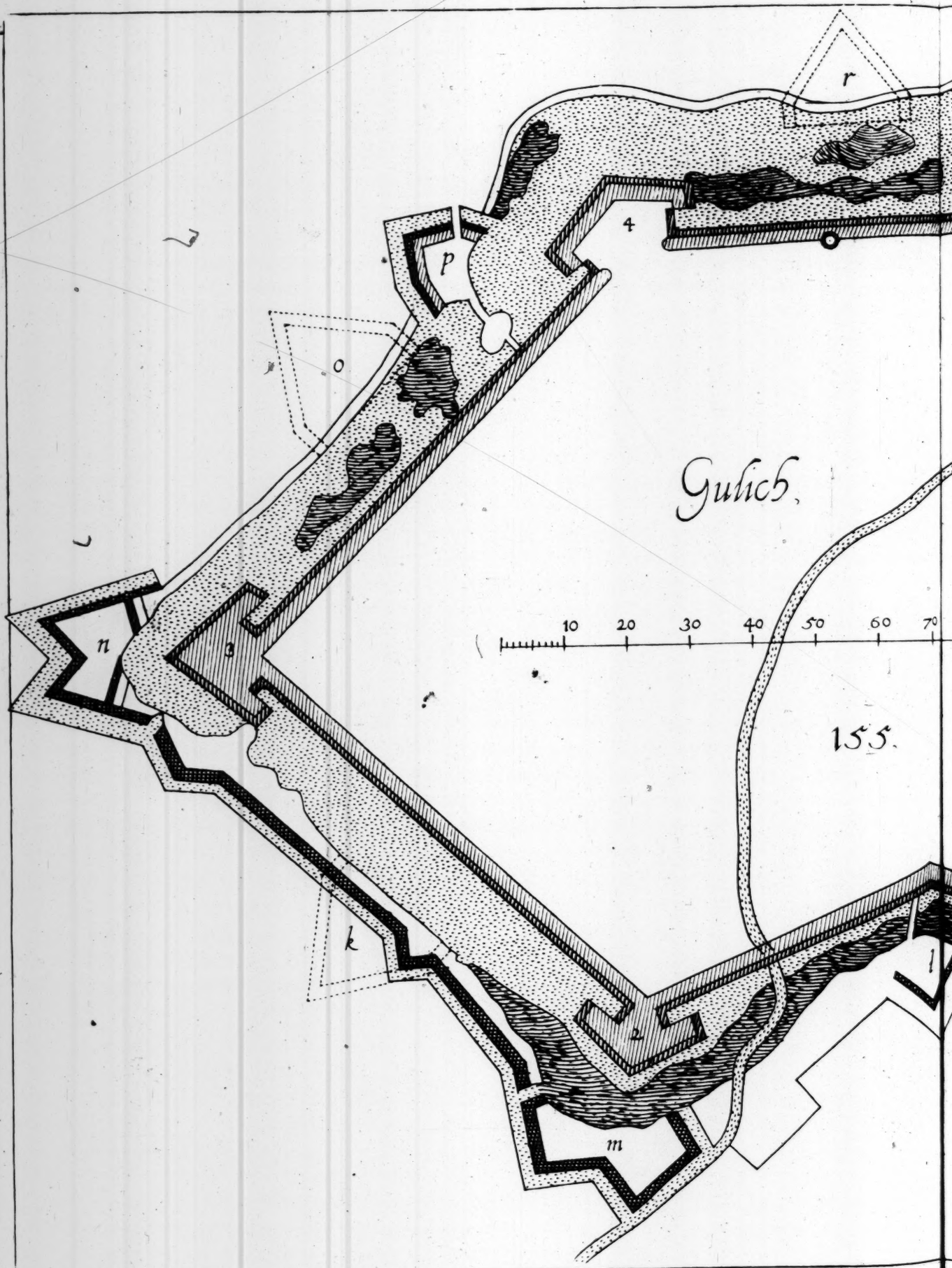


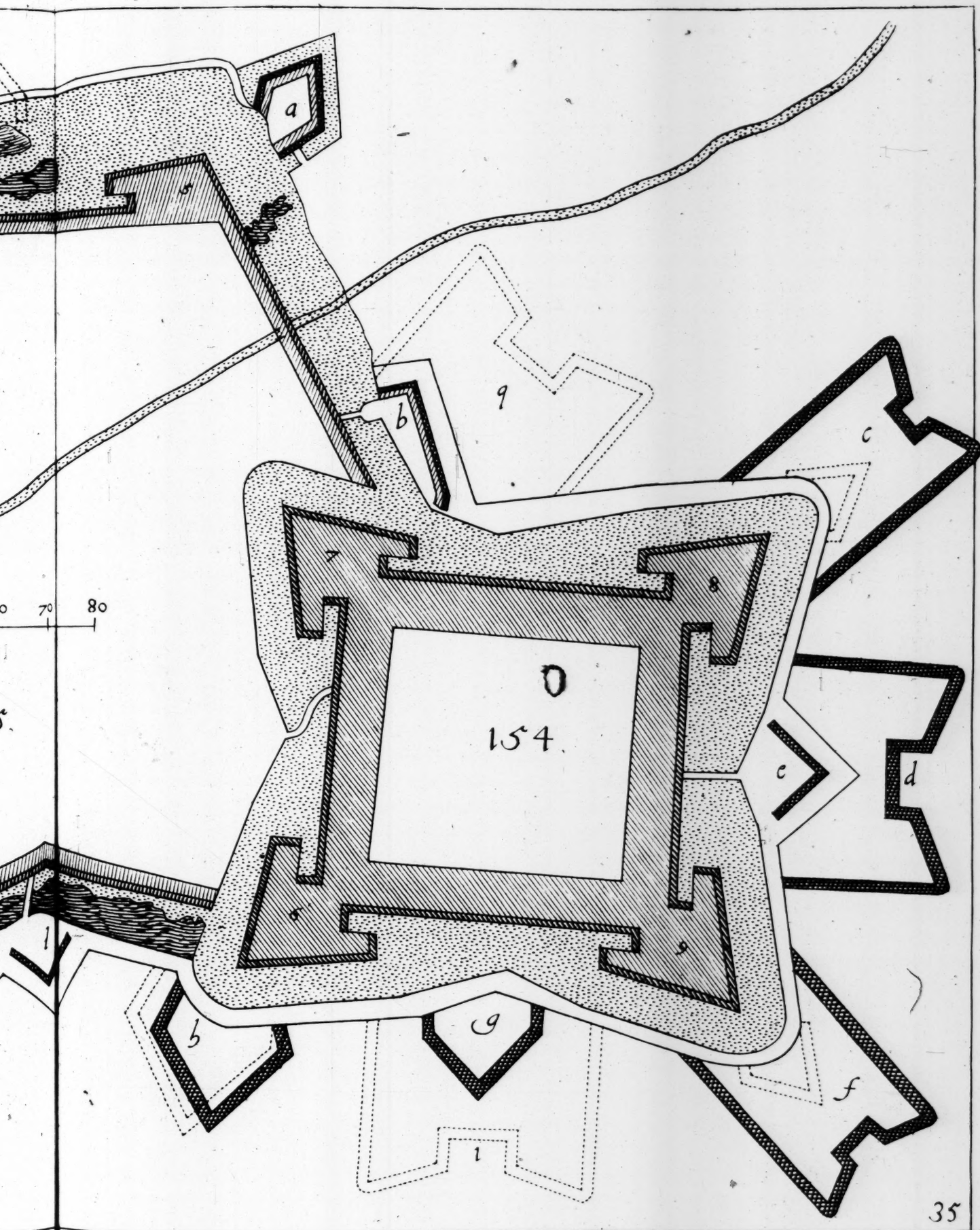
153

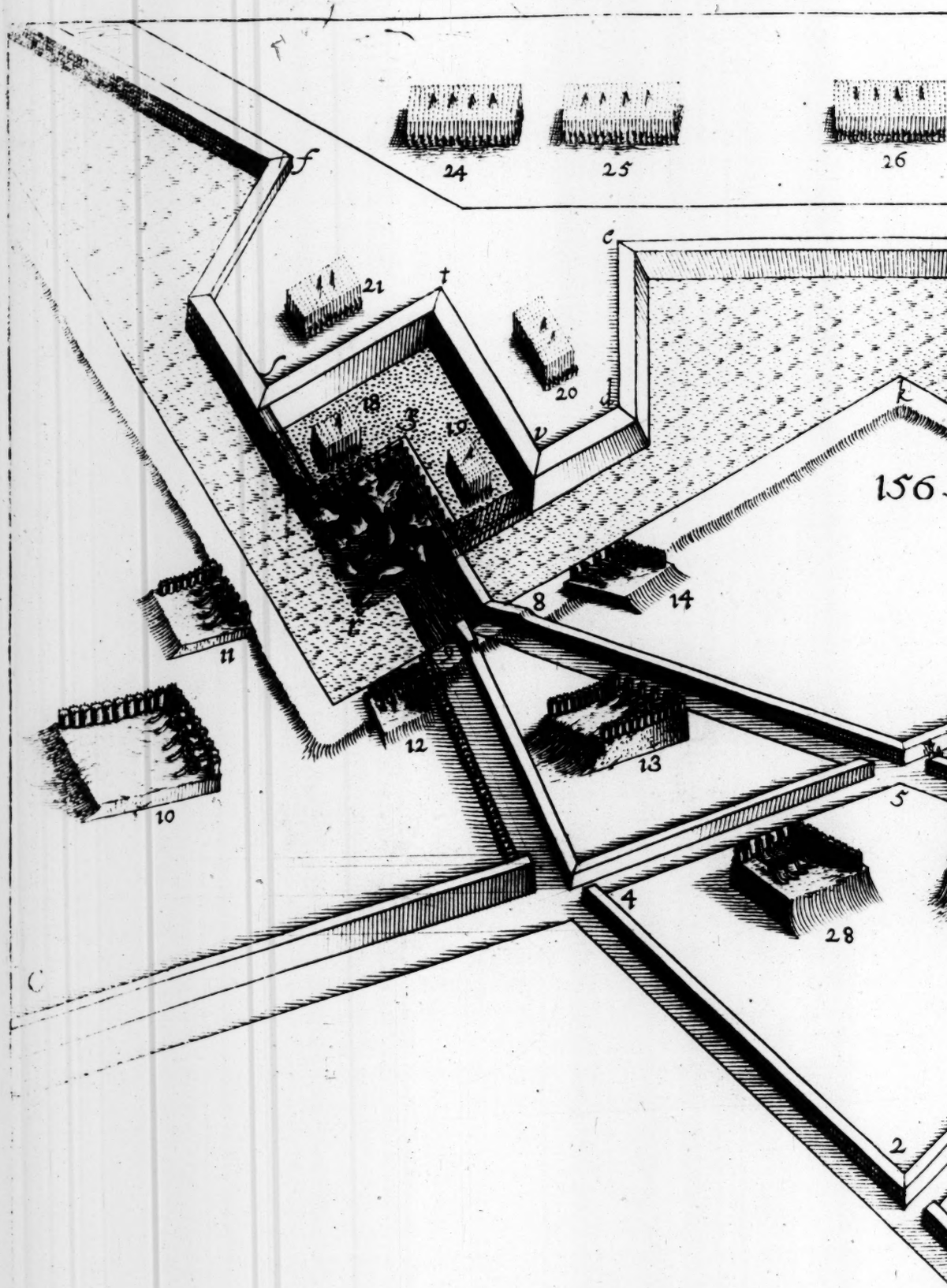


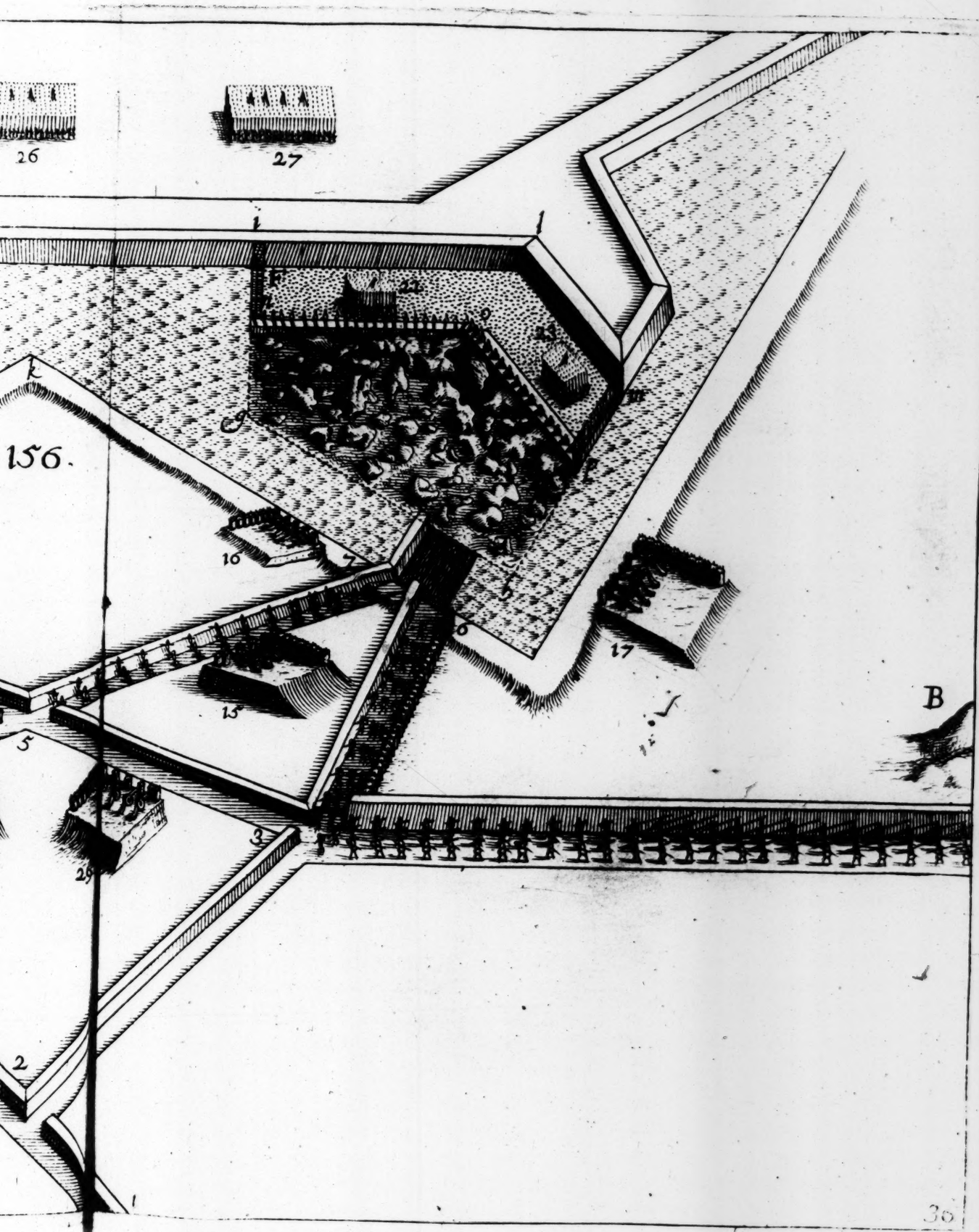


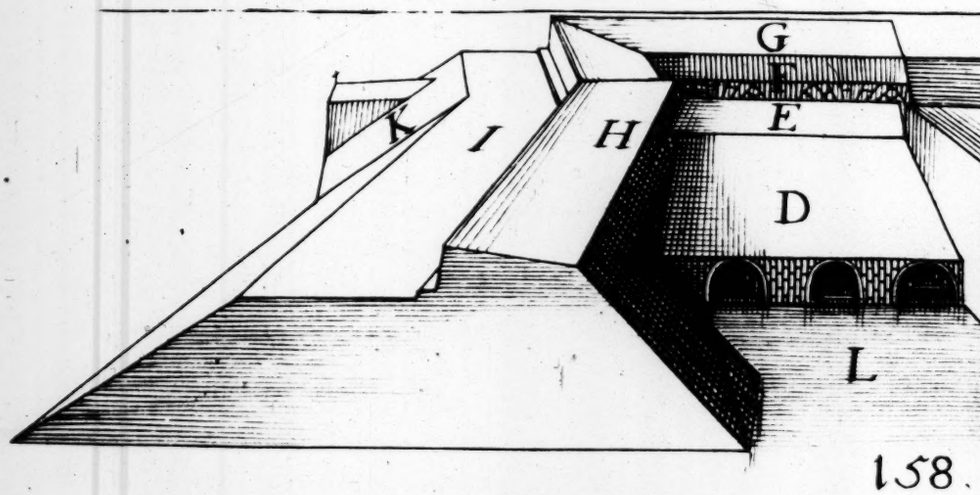
152


r
4
p
o
Gulich.
10 20 30 40 50 60 70
n
3
155.
k
2
l
m

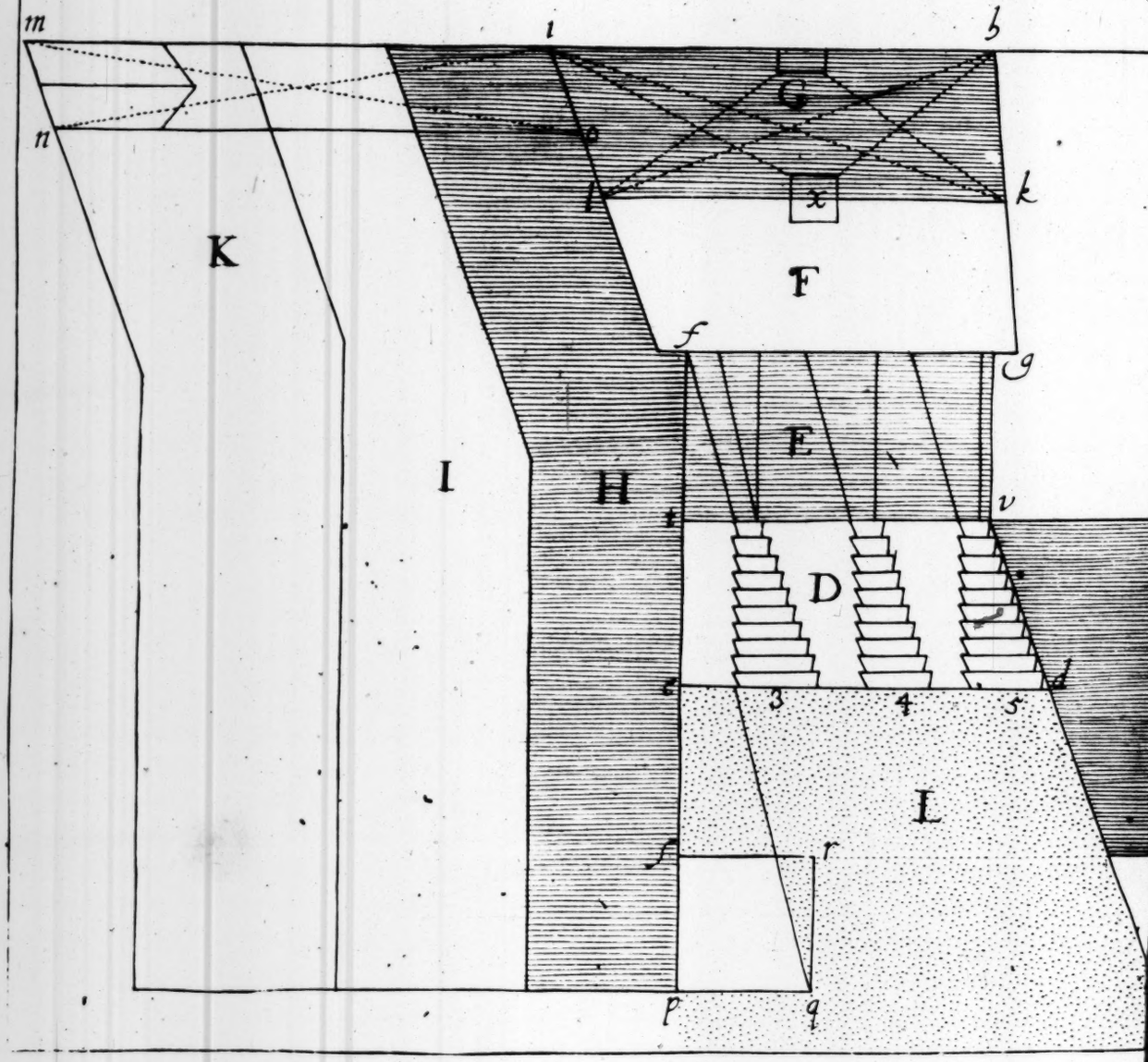

a
b
c
d
e
f
g
h
i
k
l
7
8
9
154
70
80

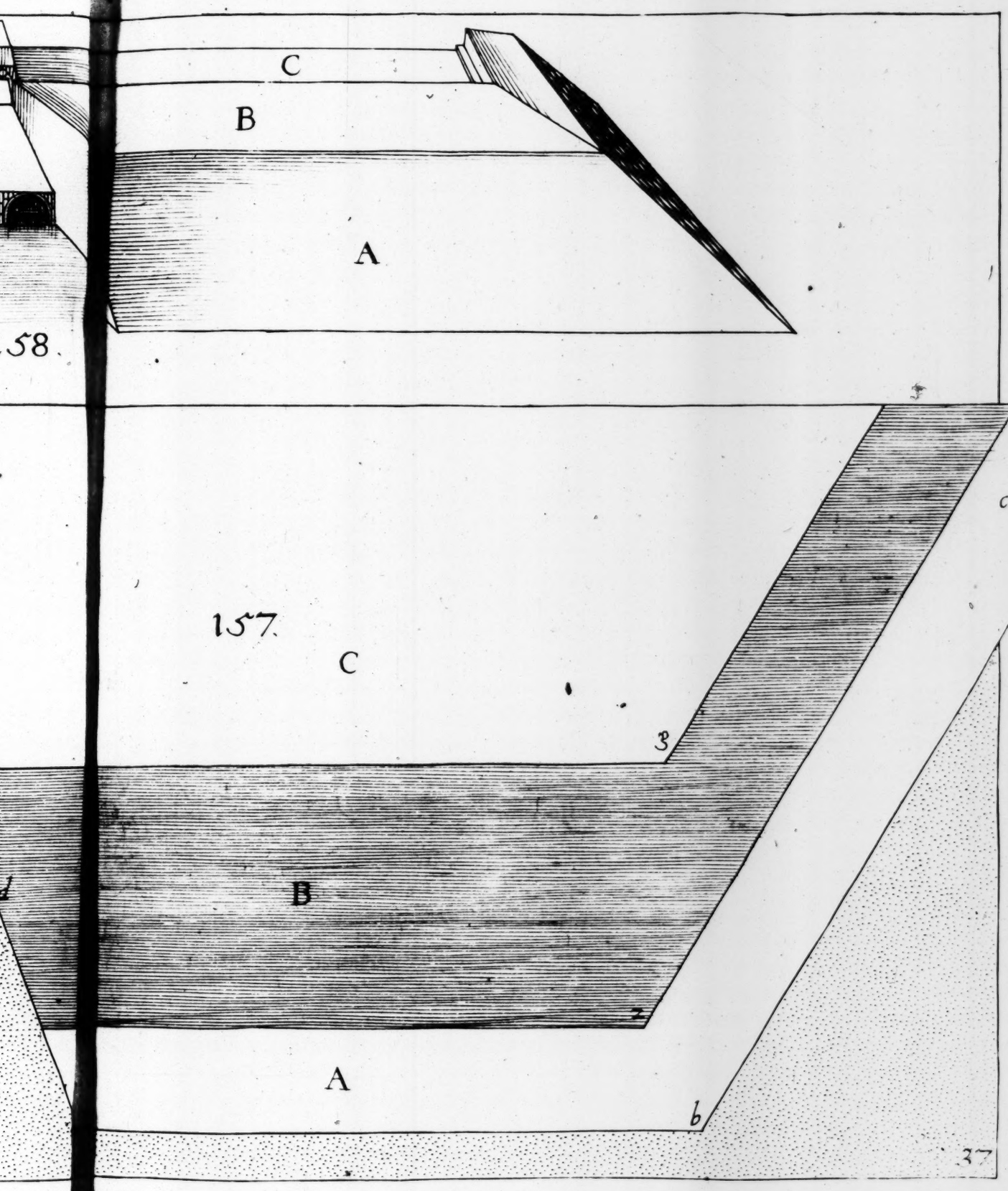

24
25
26
f
c
t
21
20
18
19
v
k
156
8
14
11
12
13
10
5
4
28
2

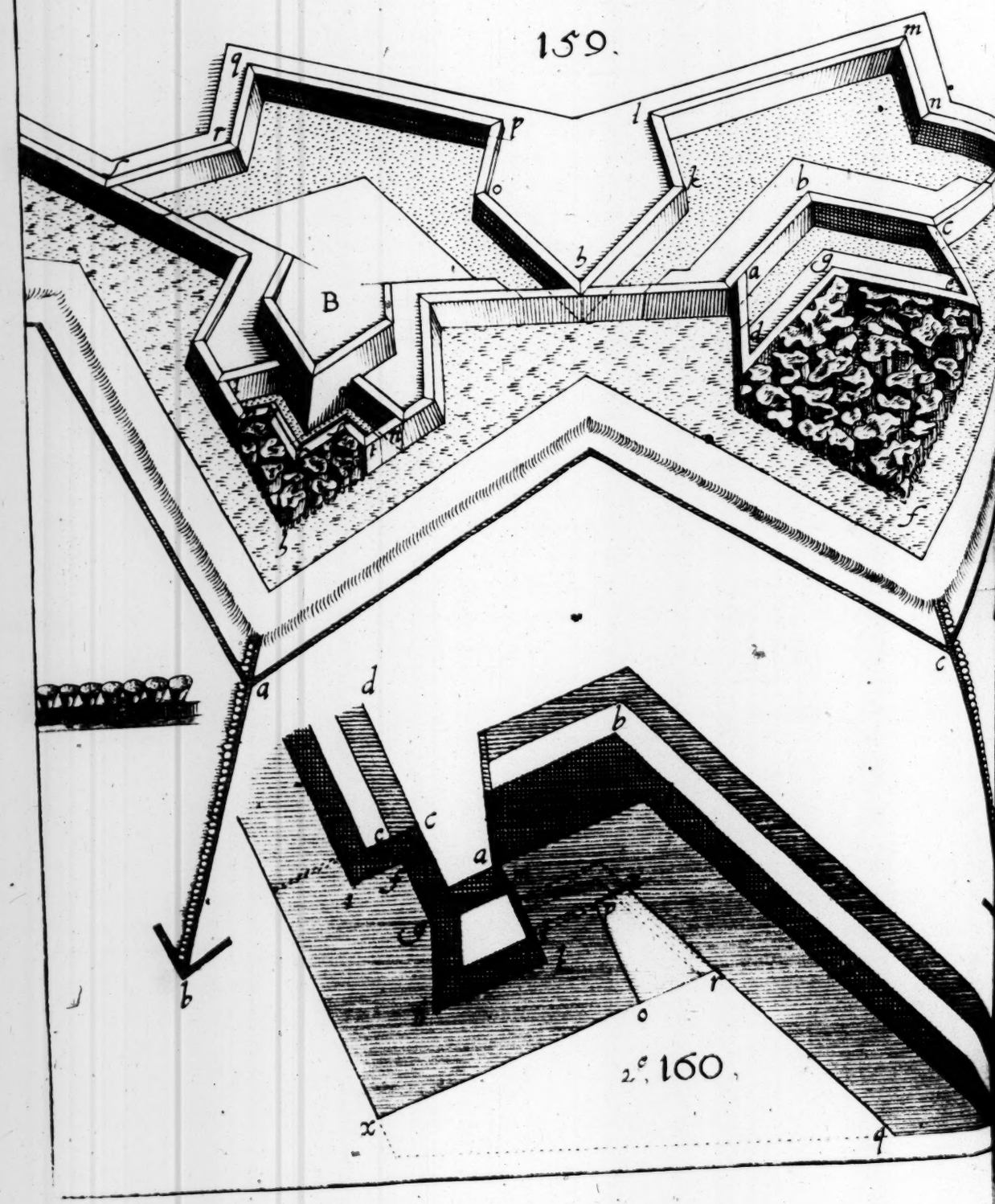

26
27
156.
B
30

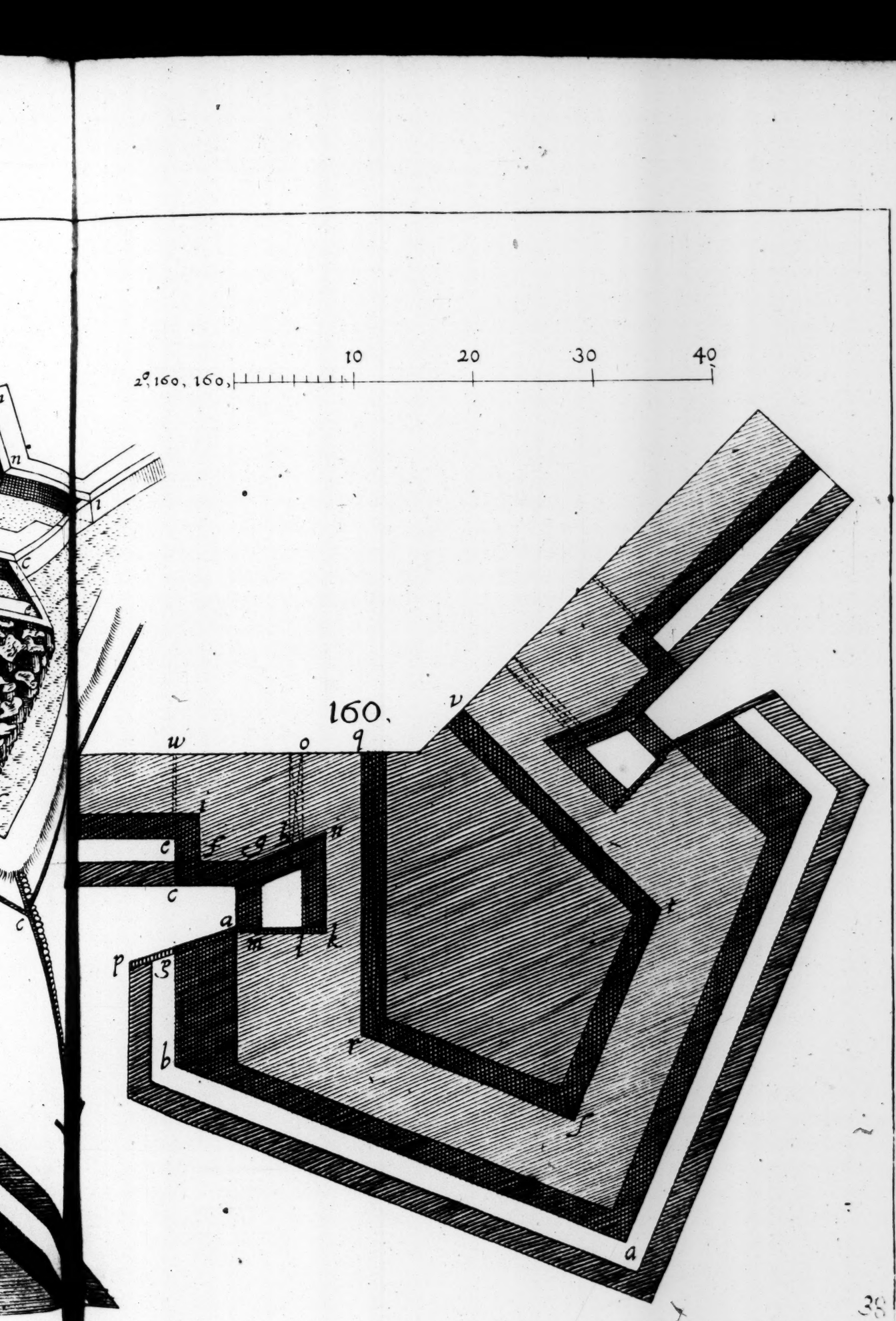


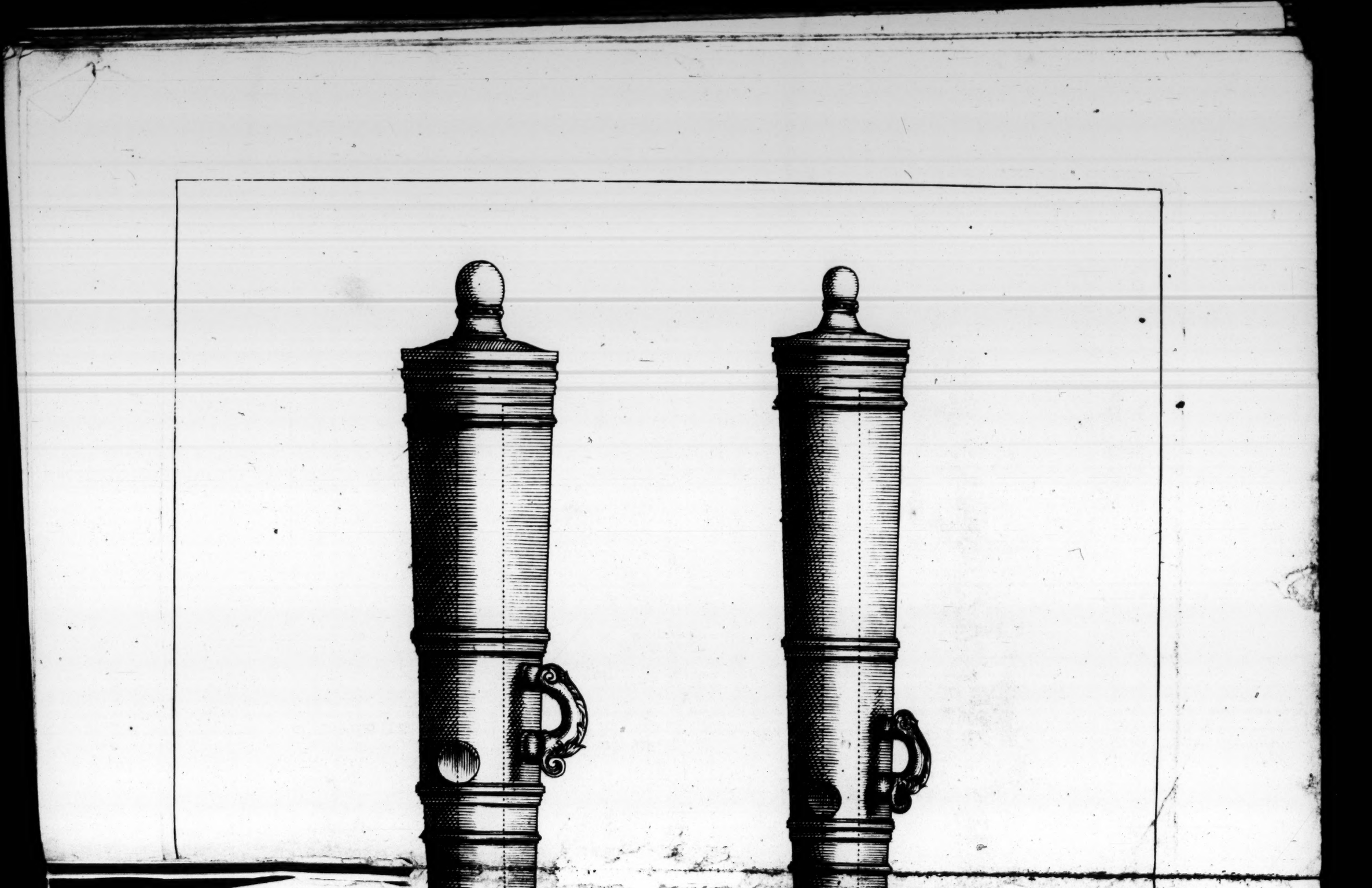
158.



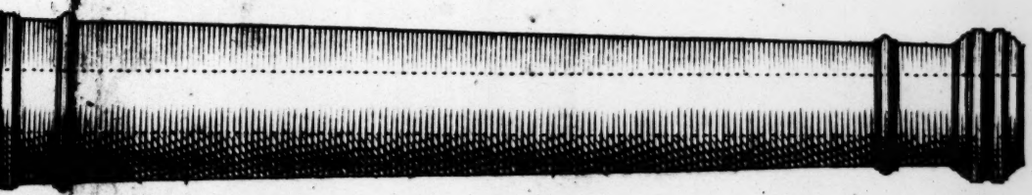

C
B
A
158.
157.
C
B
A
3
b
37


159.
B
2.e 160.


10
20
30
40
160.
v
w
o
q
c
c
a
p
b
r
s
a

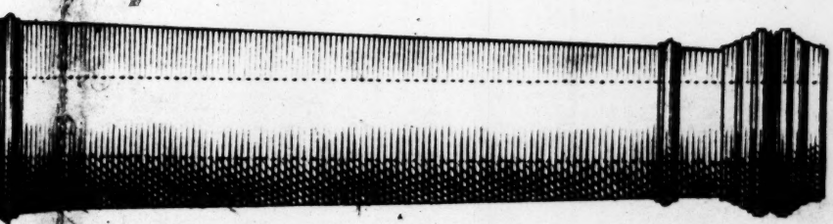


161.



6

162.



12

17451

Marolois, S.

F. 5. 23. 46

...nus, corporis habitu quàm ... Smer-
...dio, quem Prexaspes à Cambyse ... interfe-
...ctus specie tantùm corporis Smerdis ... similis
...set cognominis. Hunc fratrem ... Patizithes
...sus, quemadmodum hæc res peragenda foret,
...ei solium perducit: & statim caduceatores cùm
...in ea, tum verò in Ægyptum dimittit ad exerci-
...tum edicerent, ut Smerdi Cyri filio deinceps obe-
...mon Cambysi. Hæc igitur Caduceatores alii a-
...lii nuncia-
...nere. is quoque, qui ad Ægyptum delegatus e-
...rat (invenit autem Cambysem atque Exercitum in Ec-
...bani Syriæ agentem) stans in medio, præcepta Magi
...posuit. Hæc audiens Cambyses, se à Prexaspe pro-
...ditum esse suspicatur. Mox autem Prexaspes Caduce-
...atores assequutus, ex eo didicit, Magum, qui à Cam-
...byse constitutus est procurator rerum familiarium, hæc
...omnia dedisse. Hinc technam intellexit Prexaspes,
...fecisse, duos magos, Patizithem & fratrem ejus
...Smerdin, adversus Cambysem insurrexisse. Cambyses,
...falso Smerdis nomine, somnium sic jam impletum,
...neque sine causa fratris interemtorem fuisse agnoscit.
...Tum ubi deflevit, & de tota calamitate questus est, in
...equum insiliit, habens in animo quàm primum Susa
...versus ducere exercitum. Insilienti in equum, gladius
...vaginâ excidit, & femur perstrinxit. Ex hoc vulnere,
...ubi tumoris os viciatum est, femúrque celerrimè contabu-
...it, post viginti dies decessit Cambyses Cyri F. cùm
...regnasset septem omnino annos & menses quinque, nul-
...la unquam prole susceptâ, ut scribit *Herodotus Thaliâ.*
...Vide & quæ ex Trogo habet *Justinus sub finem libri primi.*
...Magum, qui Cambysis fratrem simulabat, Trogus O-
...thanem vocat: *Apud Ctesiam* verò, qui multo aliter
...narrat historiam, Sphendadates nominatur. Annos
...Cambysis nonnulli à primo Persici Imperii anno vi-
...detur inchoasse; quòd Cyrus regium nomen filio tri-
...buisset. Itaque *Clemens Alexandrinus* Cambysi XIX an-
...nos assignat, *Ctesias* vero octodecim.

Polycrates Samius, paucis ante Cambysis obitum diebus periit, perfidè interemtus & cruci suffixus ab Oroete Persa (qui Orontes *Valerio* dicitur) Lydiæ Satrapa. Idem, ubi primum de Cambysis morte nuncium accepit, eâdem perfidiâ Mitrobatem Persam Dascylii præfectum occidit: Ipse autem paulo post nequitiæ pœnas dedit, vitâ omnibúsque bonis à Dario Rege spoliatus. Vide *Herodoti Thaliam.* Oroetes Darii Prætor dicitur *apud Ciceronem lib.* 5. *De Finibus.* Rex Cyrus hunc Oretem Σαρδίων ὕπαρχον, Sardium Præsidem constituerat, ipsúmque Lydiæ, Phrygiæ, & Ioniæ præfecerat, ut dicit *Herodotus.*

Democedes Crotoniata, medicus insignis, unà cum Polycrate Samio ad Oroetem Satrapam navigabat, & inter Polycratis servos captivus est detentus ab Oroete: Post traductis atque comportatis Susa bonis Oroetæ, Democedes inter captivos Oroetæ illuc perductus est; ibi maximo pretio habebatur, postquàm Darii pedem luxatum, & Reginæ Atossæ mamillam sanasset. Plura de hoc medico, legere est apud *Herodotum libro tertio.* Vide & *Suidam* in Δημοκήδης.

A. M. 3484. *ante Christum* 519.
U.C. CCXXXIII. DARII I.

POST Cambysis obitum, Prexaspes Smerdin à se interfectum pernegat. Neque enim tutum ei erat tum

...fratrem Cyri. Filium ... Hinc Persæ ...
...est interpellati ... an cujus cruentâ ... viderent, re-
...rum potiri Magos: sed Smerdin Cyri F. regnare, Persasque non dubitabant. Magus igitur defuncto Cambyse securus regnavit menses septem, qui reliqui erant ad implendum octavum annum regni Cambysis: per quos menses omne genus liberalitatis in subditos exhibuit. Octavo autem mense, re prodità, Septem Principes conspiratione inter se facta impostorem è medio sustulunt. Horum nomina sunt (auctore *Herodoto*) Otanes, Gobryas, Aspathines, Intraphernes, Megabyzus, Hydarnes, Darius. Cognito Magorum dolo, Persæ magos, ut quemque reperiunt, interficiunt. Hinc festum apud Persas celebratum, quod Magophonia dicebatur. Eam Magorum cædem in quartum Olympiadis LXVIII, annum confert *Eusebius.* Mago sublato, inter Principes convenit, ut is, cujus equus die dictâ primo mane hinnitum primus edidisset, Rex esset, quasi Solis, quem pro Deo colunt Persæ, & cui equos sacratos esse volunt, judicio comprobatus. Pridie Darius in loco, qui conventui constitutus est, equum suum equæ admittit nocte concubiâ. Sub solis ortum, ubi conscensis equis adfuerunt, Darii equus ad locum accurrens, hinnitum statim edidit. Oebarem Darii equisonem suâ id astutiâ effecisse, narrat *Herodotus*, & ex eo *Polyænus Strateg. lib.* 7. *Quantum imperium, quàm parva interceptum est vaframento!* Vide *Valerium Max. lib.* 7. *cap.* 3. & *Justinum lib.* 1. *sub finem.*

Darius Hystaspis F. hoc modo regnum Persarum adeptus, regnat annos sex & triginta. Eum Cyri σωματοφύλακα seu *armigerum* fuisse scribit *Ælianus Var. lib.* 12. *cap.* 43. Hystaspes hoc tempore Persis præerat, quem *Herodotus* ait Arsamis (sive Ariaci) esse filium, & trinepotem Achæmenis, à quo & Cyrus rex paternum genus duxit. *Sulpitius Severus Sacræ Historiæ libro secundo*, Cyrum Regem & Hystaspem patrueles, hoc est fratrum filios fuisse innuit. Sic enim scribit: Ad (Magos) interficiendos septem nobilissimi Persæ conjuraverunt: quorum princeps fuit Darius Hystaspis F. natus ex fratre patruele Cyri. Ibi *Drusius* annotat, Cambysem Cyri patrem, & Arsamen Hystaspis patrem, fratres fuisse. Cognationem Dario junctam cum pristinis Regibus fuisse, ex Trogo indicat *Justinus.* Hic Darius natu maximus filiorum Hystaspis, occiso Pseudosmerdi, regnum è Magorum manibus vindicavit, equísque sui hinnitu rex declaratus est. Quod Cyro in Massagetas expeditionem facienti longè antè revelatum fuerat. Nam transmisso Araxe Cyrus per quietem videbat maximum natu filiorum Hystaspis, habentem in humeris alas, quarum alterâ Asiam, alterâ Europam inumbraret. Illo tempore Darius fermè vicesimum ætatis annum agebat, ut scribit *Herodotus* sub finem libri primi. Antequàm regnaret, uxorem duxerat Gobryæ filiam. Principio regni, duas Cyri filias in matrimonium recepit, Atossam scilicet, & Artystonam, regalibus nuptiis regnum firmaturus. Alias quoque Darii uxores *Herodotus* memorat, Parmyn Smerdis filiam, Cyri neptim; Phædymam Otanis filiam: & Phratagunen, quam unicam filiam reliquit Atarnes Darii frater. Hystaspes enim filios habuit Darium, Artabanum, Atarnem, Artaphernem.